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ABSTRACT

This manual provides information needed to meet specific standards for certification as a pesticide applicator. The first section discusses general and household pest control and is concerned with parasitic pests and man, stored product pests, and irritating vertebrates. Section two is devoted to identifying and controlling structural pests such as termites, beetles and carpenter ants. Food industry pest control is the topic of section three and deals with control and treatment for pests in storage, processing and packaging areas. The last section is concerned with community insect control, especially flies and mosquitoes, and discusses their life cycles, habits, and public health importance. (CS)

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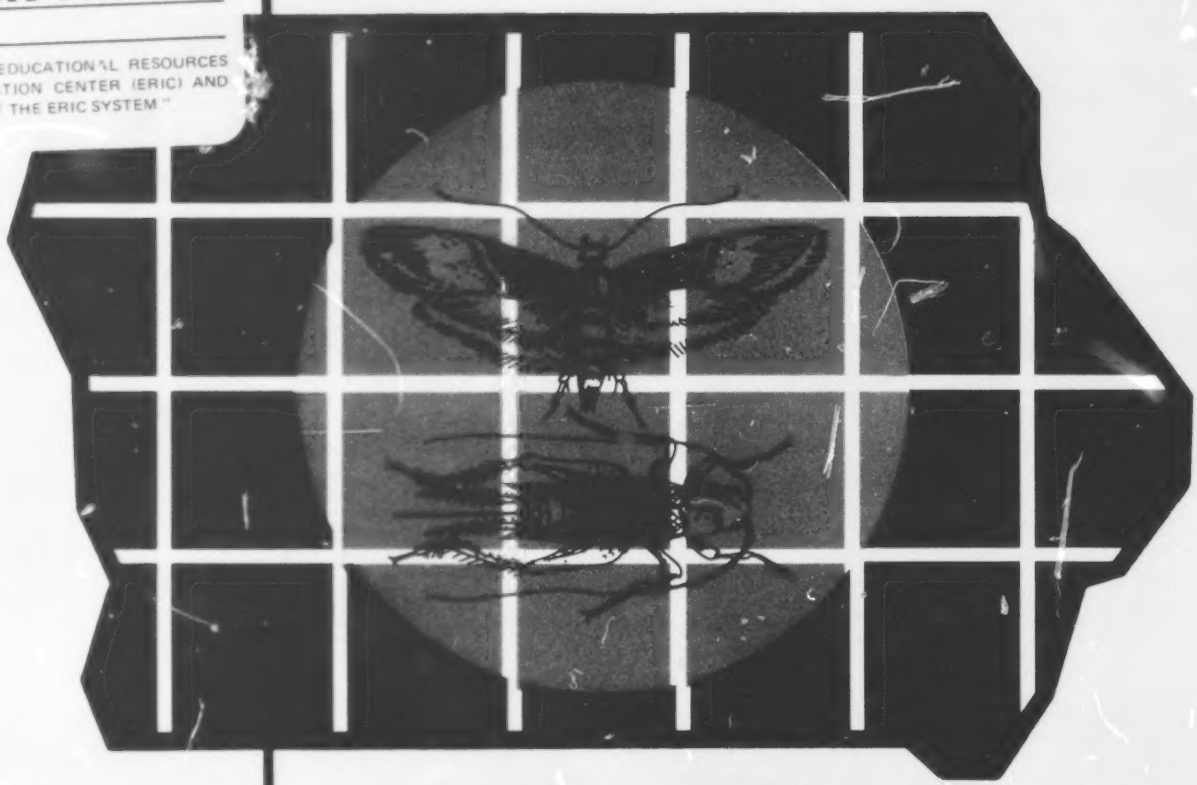
Iowa
Commercial Pesticide Applicator Manual

CATEGORY 7A

GENERAL AND HOUSEHOLD PEST CONTROL



This manual is to be used for certification training in conjunction with the U. S. Department of Agriculture – U. S. Environmental Protection Agency manual, **Apply Pesticides Correctly,** EPA-335.

Cooperative Extension Service
IOWA STATE UNIVERSITY
Ames, Iowa 50011

CS-19
September 1976

This manual has been developed for individuals wishing to become certified in commercial pesticide applicator category 7A, General and Household Pest Control. It contains specific information that an individual must know before becoming certified in category 7A. The manual has been designed to supplement the general information contained in the core manual, Apply Pesticides Correctly - A guide for commercial applicators (plus an Iowa State University supplement) and should not be used for certification preparation without referring to the core manual as well.

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Edited by Harold J. Stockdale, extension entomologist, and Jerald R. DeWitt, pesticide training coordinator, who express appreciation to Purdue University for the use of source material.

INTRODUCTION

Proper identification of pests and a knowledge of pest development and behavior are keys to effective pest control. After you have identified the pests, you must decide how to control them. Removal of food, water, and habitat (place in which to live) is an important part of effective pest control, but should be combined with appropriate chemical and mechanical control methods. If you choose to use a pesticide, select a product that has label directions for the intended use.

The various formulations can be used on a wide variety of jobs in many different types of equipment. But each formulation has its own characteristics which help determine which is the best to use in a given situation. For example:

- for a space spray, you might use an insecticide in oil;
- for long residual activity in a dry situation, a dust;
- for a residual spray, either an oil solution or water emulsion;
- for a surface application of a residual where appearance is not too important, a wettable powder spray;
- for use around open flames and heat, an emulsion;
- for use around electrical installations, an oil solution;
- for spraying on or around plants, a wettable powder or selected emulsion;
- for use on or around linoleum, rubber, asphalt floor tiles, and some synthetic fibers, a water-base insecticide.

USING PESTICIDES SAFELY

Do not release pesticides into soil, air or water except where you intend to do so as a safe and approved part of your work. Pesticides put in the wrong place, or on the wrong plant, or where the wrong animal can contact or consume them are pollutants and may cause serious harm.

Use special care in sensitive areas such as food handling establishments and where children, elderly people or ill people are located. Pets and their eating places also must be kept in mind. Pesticides used in or around such areas should be the safest ones available that are effective. Apply them so that contamination does not occur.

GENERAL INSECT PESTS

COCKROACHES

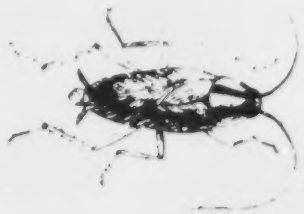
Four species of cockroaches are commonly found throughout the United States. They vary somewhat in appearance and habits but in general are all flat, brownish or dark, and fast-running. Cockroaches seek cover in the daytime or when disturbed at night. They may be carried into buildings in boxes and beverage cases, and with groceries. In apartments and larger buildings, they readily migrate from one room to another along water pipes, cracks in the walls, and wall voids. Some species may enter structures from outdoors or come in through sewer lines.

The stages in the life cycle of a cockroach are:

- the egg, enclosed in a capsule which contains several eggs,
- several stages of nymphs, which look like the adults but are smaller and have no wings, and
- the adult.

German Cockroach

- A common species found in kitchens.
- Adults are about ½ inch long.
- Tan with two dark stripes running lengthwise on the area just behind the head.
- Often occur in large numbers.



American Cockroach

- Reddish-brown; margins of prothorax (behind head) lighter.
- Largest of the common cockroaches (adult about 1½ inches long).
- Found in dark, moist areas such as basements, sewers, and steam heat tunnels.

American Cockroach

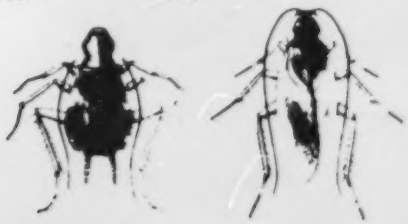
Oriental Cockroach

- About 1 inch long as an adult.
- Shiny black or very dark brown.
- Female has small wings; wings of the male cover about ¾ of his abdomen
- Often found in damp places such as basements. May enter buildings through sewer openings.
- May live outdoors during the summer months and move from building to building.

Female Male

Brown-Banded Cockroach

- About ½ inch long.
- Brown with two lighter bands across the base of the wings and abdomen.
- May infest an entire building.
- Infestations usually start from luggage, furniture, or other materials shipped from one place to another.



In some areas of the country, there are other cockroach pests. Some of these are very similar in appearance to those described above but differ in their habits. As a result, proper identification is essential to control. Contact local experts for information on other species that may be important. The removal of food and water sources and destruction of breeding places is essential in obtaining satisfactory cockroach control.

In kitchens and living areas, apply insecticides as crack and crevice or spot treatments to places where the insects hide. Label directions of residuals permit only crack and crevice treatment to be used in commercial food handling areas. Common "hideouts" are behind and beneath built-in shelves and cabinets, in and beneath stoves and refrigerators, under sinks, and behind baseboards.

In basements, cockroaches hide beneath trash, in cupboards and washing machines, and in cracks and crevices in concrete, brick, or block walls. Sprays are usually preferred to dusts because they are easier to apply and the residue is not as visible. Dusts, however, can sometimes be blown into places difficult to reach with spray.

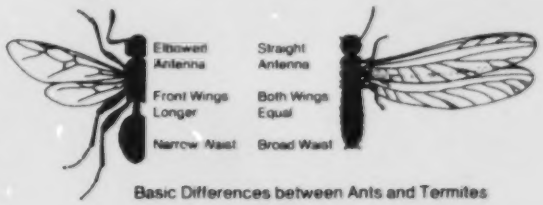
Use ULV (ultra low volume) and aerosol applications of contact sprays and flushing agents to supplement residual sprays and dusts. Use them alone where the label prohibits use of residuals.

ANTS

The stages in the life cycle of an ant are:

- egg,
- larva,
- pupa, and
- adult.

During the year, ant colonies produce winged individuals. These are often mistaken for termites.



Basic Differences between Ants and Termites

Carpenter Ants

- Variable in size, measuring up to ½ inch long.
- Red to black.
- Either winged or wingless.
- Build nests in hollow trees, logs, telephone poles, posts, porch pillars, and other wood used in homes.
- A small pile of coarse sawdust beneath wood with a higher than normal moisture content is a common sign.

- Do not eat wood but simply hollow it out to form nests.
- Can weaken structures.

Carpenter Ant

Other Ants

- Most build their nests in soil.
- Those that invade buildings usually nest near foundation walls, in lawns, or under concrete slabs.

Control both carpenter ants and other indoor- or outdoor-nesting ants by direct treatment of the nests. Locate the entries of carpenter ants. Then blow an insecticide dust into the nesting area. Control other ant species with sprays, dusts, or granular insecticides directed at the nest and surrounding area. Baits may be used effectively.

If you cannot locate the nest site, apply insecticides where the ants gain entry or hide—along foundation walls; at doorways, windowsills, and baseboards; behind built-in cabinets and furniture; or beneath refrigerators and other heavy appliances.

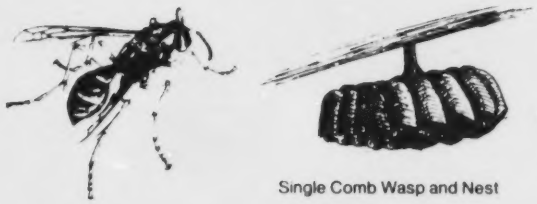
BEES AND WASPS

Bees and wasps are nuisances and may be dangerous to man because of the female's ability to sting. These insects have similar life cycles, including:

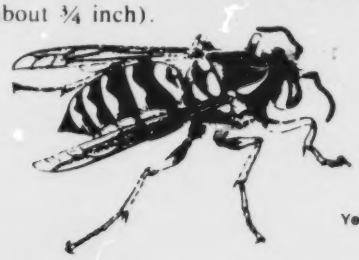
- egg,
- larva,
- pupa, and
- adult.

Paper Wasps

Paper wasps include the single comb (*Polistes*) wasps, hornets, and yellow jackets. Single comb wasps build open comb nests under eaves of houses, in shrubs, and in other protected places. Hornets' nests are large, covered, grayish-brown paper structures usually seen hanging in trees or bushes. Yellow jackets often build their nests above as well as underground. These wasps vary in color. As a general rule, the hornets are largest (about 1½ inches long), the single comb wasps are intermediate in size (about 1 inch) and the yellow jackets are smallest (about ¾ inch).



Single Comb Wasp and Nest



Yellow Jacket

Special protective clothing is needed when controlling paper wasps. Insecticide sprays work well, but they must be applied at night with a sprayer large enough to do the job quickly without getting too close to the nest. Dusts may be blown into the nest openings of hornets and yellow jackets. Baits are also available for use against some species of wasps.

Solitary Wasps

Solitary wasps may dig holes in lawns or bare earth to build their nests. **The cicada killer:**

- is a black and yellow wasp about 1½ inches long,
- will not sting or otherwise cause harm (only the males buzz around people), and
- can be controlled by directing dusts or sprays at the entrance to its burrow.

Mud Dauber Wasps

These wasps:

- are so named because they construct their nests of mud in protected places,
- are usually black with yellow markings,
- are not dangerous since they do not aggressively defend their nests,
- can be eliminated simply by tearing down their nests.

Bees

Bees such as the **honey bee, bumble bee,** and **carpenter bee** are pests in and around buildings. Structural damage results from their nest-building activities.

Honey bees may build nests in walls, chimneys, and attics. Their combs may melt and allow honey to seep through walls. In addition, the combs may be infested by other insects.

Bumble bees build their nests in the ground, in straw or rags, or in buildings.

Three Castes of Honey Bees

Carpenter bees drill ½ inch holes into exposed wood. The holes make a 90-degree turn below the surface and run with the grain of the wood for distances up to 12 inches.

Bumble bees and carpenter bees look very much alike. Bumble bees, however, have yellow hair on the top of the abdomen.

Control bees by directing insecticides at the nest. It is wise to wear clothing to protect against stings when treating nests of honey bees and bumble bees.

PARASITIC PESTS OF MAN

Many insects, such as **bed bugs, fleas, ticks** and **mosquitoes,** feed directly upon man and other warm-blooded animals. In addition to their bloodsucking activities, many are able to carry disease-causing organisms from one animal to another or to man.

BED BUGS

- Prefer man as their host.
- Hide in cracks and crevices and come out to feed in the dark, usually as the host sleeps.
- Adults are about ¼ inch long, reddish-brown, with oval, flat bodies.

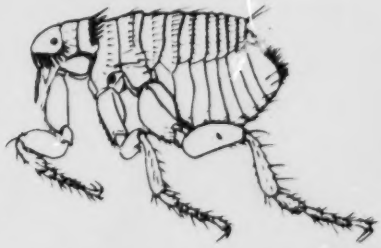
Bedbug

The stages in the life cycle of a bedbug are:
- the egg, glued inside cracks and crevices,
- nymphs, and
- the adult.

Either sprays or dusts can be used for control. Dusts are preferred behind baseboards, window and door casings, and in other cracks and crevices. Do not treat surfaces that will come in direct contact with humans. Treat tufts and seams of mattresses and cover them with sheets after the spray has dried.

FLEAS

Fleas are small insects without wings.



The stages in the life cycle of a flea are:
- the egg,
- larva,
- the pupa, and
- the adult.

Flea infestations in homes are usually noticed after a host animal (usually a cat or dog) has been removed. Adult fleas that develop from eggs laid earlier begin to bite people in the absence of normal hosts. Eggs may hatch over several months.

Control fleas in structures by using surface and crack and crevice sprays. Control them on animals by using dips, sprays, flea collars, or dusts. The pest control specialist can treat the premises; however, the pet should be treated by the owner or by a veterinarian.

TICKS

A number of ticks are parasites of man and other animals.

Hard Tick

The stages in the life cycle of a tick are:

- egg,
- six-legged larva,
- nymph (or nymphs), and
- adult.

The **brown dog tick:**

- is a common household pest,
- may be found on other animals, although the main host is the dog,
- will drop off the host after feeding and conceal itself in any available crack or crevice such as behind cove moldings and window frames and in furniture.

This tick is difficult to control because of its many potential hiding places. Eggs may hatch over a period of up to 5 months. Hiding places may need to be sprayed at monthly intervals to eliminate this tick. The owner or a veterinarian should treat dogs, using dips, sprays, or dusts.

MOSQUITOES

- May occur in large numbers in the warm-weather months.
- Adult females feed on warm-blooded animals and birds.
- May develop in standing water.

The stages in the life cycle of a mosquito are:

- the egg, which may be laid on water or in areas which later will be flooded, depending on the species,
- larva, found only in water,
- the pupa, also found only in water, and
- the adult.

Effective control requires community-wide efforts. Elimination of all mosquito breeding habitat is essential. Control mosquitoes in smaller areas for a limited time by using sprays, aerosols, or fogs.

OCCASIONAL INVADERS

The term "occasional invaders" includes those pests which may occur in buildings at some stage of their life cycle, but which do not usually complete the entire life cycle within the building.

CLOVER MITE

- Is an annoying household pest, especially in housing developments where turfgrasses are newly established and there is a heavy growth close to foundation walls.

Stages in the life cycle of a clover mite are:

- the egg—laid in foundation cracks and other protected places,
- larva,
- nymph, and
- adult.

Clover mites are difficult to control. Methods that keep the mites from getting indoors give the best results. These methods include:

- establishing a plant-free strip 18 to 24 inches wide along foundation walls and directing pesticide sprays at the strip and walls, or
- if a plant-free strip cannot be established, spraying the foundation walls and the adjacent 10-foot strip of grass.

MILLIPEDES

- Are gray or brown cylindrical worms ½ to 1½ inches long.

- Have two pairs of short legs on each body segment.
- Curl up when disturbed.
- Are common on the forest floor, in compost piles, and in heavily mulched areas.

Millipede

The stages in the life cycle of a millipede are:
- egg,
- nymph, and
- adult.

When millipedes leave their natural habitats, they crawl over lawns and sidewalks and may invade buildings in large numbers. They cause no damage.

Prevent invasion by removing leaves and compost around buildings and by sealing cracks in foundation walls and around doors, basement windows, crawl spaces, and vents.

Spraying a 10-foot wide strip around the foundation is helpful in control. Repeat applications may be necessary during periods of heavy migration.

FLIES

Several species of flies may be found in and around structures.

The stages in the life cycle of a fly are:
- the egg, deposited in a moist place,
- larva,
- pupa, and
- adult.

Filth Flies

The more common of these are the **house fly** and the **black blow fly.** The black blow fly is slightly larger than the house fly and is a shiny black or green. These flies are annoying and also may carry diseases of man.

Successful fly control must include a combination of sanitation, physical barriers (such as screens), and insecticides. Garbage, manure, and decaying plant and animal material must be removed. Control adults by spraying resting places. Baits can also be used. Impregnated resin strips can be used in some indoor situations.

Control of adult filth flies around livestock and poultry feeding operations requires the cooperation of the pest control specialist, the livestock producer, and the county sanitarian.

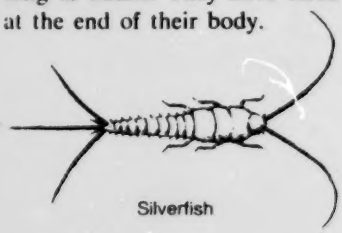
Cluster Fly

- Often a pest indoors, buzzing around and collecting in large numbers in light fixtures and at windows on warm, sunny days.
- Slightly larger than the house fly and more sluggish.
- Adults seek protected places such as wall voids and attics to spend the winter.
- Screens are ineffective since the flies prefer to crawl in through small openings elsewhere.
- On warm days, they enter rooms through window pulley holes, around baseboards and through other small openings.

Control is difficult. If possible, close all openings through which the flies can enter. Apply sprays and dusts to surfaces where flies are frequently seen and, where possible, into wall voids and other confined spaces where the flies may be. In unventilated areas, impregnated resin strips are effective.

SILVERFISH AND FIREBRATS

Silverfish and firebrats are wingless insects about ½ inch long as adults. They have three long "bristletails" at the end of their body.



Silverfish

The stages in the life cycle of silverfish and firebrats are:
- the egg,
- young, and
- adult, which continues to molt throughout its life span.

They feed on stored foods, paper, and almost anything containing proteins or carbohydrates. Directed sprays applied to cracks and crevices that serve as hiding and resting places are most frequently used for control; dusts and baits may also be used.

BOOKLICE

Booklice (psocids) are very small ($\frac{1}{20}$ to $\frac{1}{10}$ inch), light-colored insects that may be found indoors and out. Indoors they frequent damp places around stored foods and books and in crawl spaces. They feed on molds and fungi. They do little damage and are pests by being present, often in tremendous numbers.

The stages in the life cycle of booklice are:

- egg,
- nymph, and
- adult.

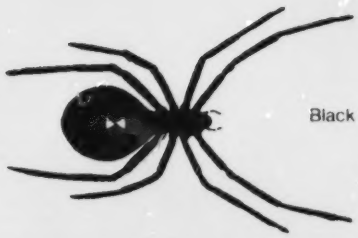
They can be serious pests for manufacturers of food products and containers. Control booklice by removing moisture and food sources. Directed sprays and aerosols are effective in control.

SPIDERS

Spiders are pests because of their webs. The **black widow** and the **brown recluse (fiddleback)** can seriously injure humans. Neither spider bites unless provoked.

A spider develops from an egg into an immature spider which may molt several times before becoming an adult.

The female black widow is shiny black and distinctively marked with a red or yellow spot on the underside of the body, sometimes in the form of an "hourglass". This spider lives under rocks and boards and in or around buildings.



Black Widow Spider

The brown recluse spider is tan to brown with a dark brown fiddle-shaped pattern on the front half of its back. It is usually found in buildings such as barns, sheds, garages, and houses that are dry, littered, undisturbed and contain insects that serve as food. Favorite hiding places seem to be the arms or legs of garments left hanging undisturbed. People are sometimes bitten while sleeping in beds or wearing clothes that have been unused for a length of time.

Brown Recluse Spider

Control spiders by controlling insects that serve as food, and by removing webs. Direct pesticide sprays or dusts at hiding areas.

FABRIC PESTS

Carpet beetles and clothes moths attack a variety of woolen products, furs, feathers, and hair. Infestations are common in boxes of old clothing, overstuffed furniture, woolen carpets, and piano felt. The larval stage causes the damage. The presence of adults in an area may be the first sign of an infestation.

The stages in the life cycle of beetles and moths are:

- egg,
- larva,
- pupa, and
- adult.

Black Carpet Beetle

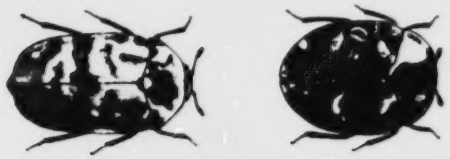
- These are the most widespread and damaging of the carpet beetles.
- Adults are shiny black and about $\frac{1}{8}$ inch long.

- Larvae are up to ½ inch long, yellowish-brown, carrot or cigar-shaped, and have a long brush of tail bristles.

Black Carpet Beetle

Other Carpet Beetles

- Adults are oval, about ⅛ inch long, and brightly colored in various patterns of white, brown, yellow, and orange.
- Larvae are about ¼ inch long, light brown to black, fuzzy, and slow-moving.



Webbing Clothes Moth and Casemaking Clothes Moth

The webbing clothes moth adult is buff-colored with reddish hairs on the top of its head. The casemaking clothes moth is light brown and has three dark spots on each wing. The larva of the webbing clothes moth usually spins feeding tunnels of silk as it moves over its food sources. The casemaking clothes moth larva carries with it a small silken case that it spins around itself. To this case are attached bits of the fiber on which the larva is feeding. It attaches the case to walls or ceilings when it enters the pupal stage.

Prevention is a very important part of fabric pest control. This can be done by cleaning fabrics correctly and storing them in tight containers with moth crystals. Control infestations by treating all infested areas with directed sprays.

STORED PRODUCT PESTS

Most food products may be attacked by insects commonly referred to as "pantry pests". They eat or contaminate the products and may make them unfit for human consumption. They often leave the infested products and move about inside structures. To eliminate infestations, find and destroy infested materials and treat the area where they are stored. Infested materials can be fumigated. Thorough cleaning is essential to remove spilled food to prevent reinfestation.

GRAIN AND FLOUR BEETLES

The **confused** and **red flour beetles,** the **saw-toothed grain beetle,** and the **cigarette** and **drugstore beetles** are small, reddish-brown insects usually less than ⅛ inch long. Their larvae are small and yellowish white with brown heads. The adults often crawl over infested material and adjacent surfaces. Larvae and adults will be found in the infested material.

Red Flour Beetle

Saw Toothed Grain Beetle

Cigarette Beetle

Drugstore Beetle

CABINET BEETLES

Adults have various colored patches of scales on the back and are 1/8 inch long. The larvae are fuzzy, light brown to black, and about 1/4 inch long. The larval stages do most of the damage. Adults feed mainly on flower pollen outdoors but may feed on stored food products.

INDIAN MEAL MOTH

The Indian meal moth is a small moth with a wingspread of about 1/2 inch. Its forewings have a coppery color on the outer two-thirds and whitish gray near the body. The pinkish-white caterpillars cover the materials on which they feed with loose webbing. The adults fly about near the site of the infestation. The larvae may also leave their food and crawl over adjacent surfaces. This is the most common moth which attacks stored food products.

ANGOUMOIS GRAIN MOTH

The Angoumois grain moth is a tiny moth similar in size and color to clothes moths. It may be seen flying about in the daytime, whereas clothes moths avoid light. The caterpillars develop within whole kernels of grain.

GRAIN WEEVILS

The **granary** and **rice weevils** primarily attack stored whole grain. Adults are reddish-brown to black, about 1/8 inch long, and have pronounced snouts. Their larvae are small, white, legless grubs that feed and develop inside individual kernels of grain.

The stages in the life cycle of a weevil are:

- egg,
- larva,
- pupa, and
- adult.

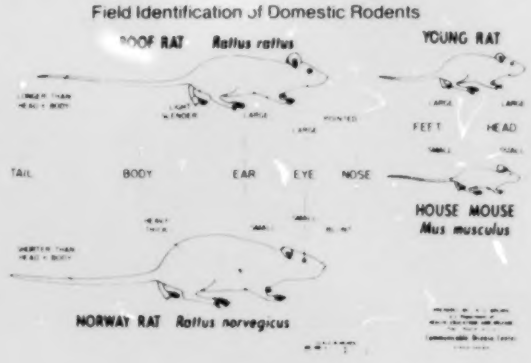
VERTEBRATES

RODENTS

- Contaminate and destroy food products.
- Damage furniture, clothing, structures, and other nonedible items.
- Carry diseases and ectoparasites.
- Sometimes bite children and adults.
- Can cause fires.
- Have the ability to coexist with man.

The three most common kinds are:

- Norway, brown, or common rat,
- roof or black rat, and
- house mouse.



The Norway rat prefers to live in undergroand burrows, but can climb readily. The roof rat prefers to live in upper portions of a building, but may use burrows. The house mouse lives in any convenient protected space inside or outside.

A rat or mouse control program is based on knowing:

- where they live, feed, and travel, and
- the extent of the infestation.

You must eliminate shelter, food, and water. All entrances the rats or mice use to come and go from buildings must be closed. These preventive measures are the key to successful control. To prevent rodent migration, it is best to poison or trap before making environmental changes.

The two categories of rodenticides are multiple-dose anticoagulants and single-dose toxicants. Each rodenticide has special characteristics, uses, and hazards. Some are highly toxic to humans and pets. Mix, handle, and apply them according to label directions. Keep baits away from people and desirable animals. Place them deep into burrows or use bait stations. Dispose of excess baits and dead animal carcasses frequently.

Mice will eagerly sample new food. Rats, however, usually approach new food with caution. If it tastes bad or makes them sick, they will not eat it again. This is "bait shyness". When using bait for control, use a bait that is fresh and identical to the food the rats are using. If you use a different bait base, prebait in the area for a few nights before using a toxic bait. Rats require water to drink. Mice may get water from the food they eat. If all water sources can be eliminated, liquid baits are very effective for rats but only moderately so for mice.

Both rats and mice prefer to run next to walls or other surfaces. Place traps and baits in these runways. Traps may be used with bait, or the trigger device may be expanded and used without bait. Place trigger end of the trap toward the wall. Rats approach new objects cautiously and may be "trap shy".

The mouse investigates any new object or change in its territory, so that changing placement of baits or traps will improve control. Each male house mouse establishes a territory which may not extend more than 10 feet from the nest. For this reason, baits and traps should be placed no more than 10 to 20 feet apart. To encourage mice to range farther to find food and water, disrupt their environment as often as is practical.

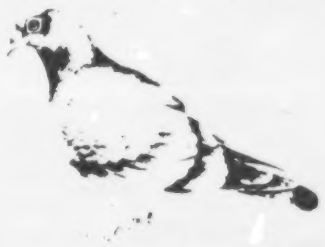
BIRDS

Birds are pests when they:

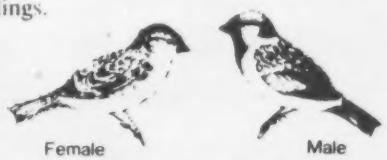
- deface and destroy structures, plants, and other property,
- cause disturbances with their noise and droppings,
- contaminate food supplies,
- carry various diseases and ectoparasites.

Birds that may require control are **pigeons, English sparrows** and **starlings.**

Pigeons are pests in towns and cities where they deface buildings with their droppings and nests.

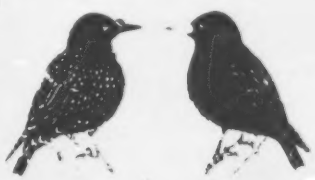


Sparrows are small birds that often nest in or on buildings.



Sparrows

Starlings are pests in the city and rural areas. They are dark, short-tailed birds, intermediate in size between pigeons and sparrows. They are objectionable when they roost in large numbers near human dwellings.

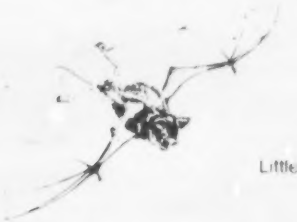


Sanitation is the first step in control. Remove food, water, and habitat. Control methods include building out, removing food, and using repellents, traps, or avicides.

Building out involves using new construction features or modifying existing features so that birds cannot roost or nest. Repellents include various devices or substances installed on buildings, such as noise makers (distress calls), charged wires, and repellent glues or jellies. Traps are often used successfully in pigeon control, especially when prebaited for a few days. Population reduction includes shooting (where permissible) and the use of avicides. Chemical control is probably the most effective method. Follow label directions closely.

BATS

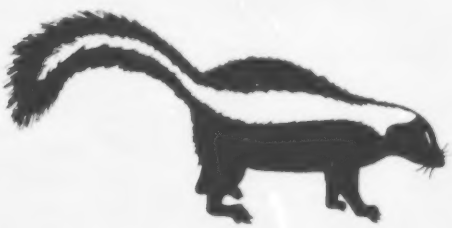
Bats are night flying mammals. They have leathery membranous wings. They roost in attics, hollow walls, chimneys, caves, barns, hollow trees and other similar places. In addition to the general nuisance and odors associated with bat infestations, they harbor ectoparasites that may attack man. They carry and are subject to rabies. Bats can best be controlled by closing all openings through which they may enter structures to roost. Carefully observe bats leaving roosting areas. Locate and close entrance openings.



Little Brown Bat

SKUNKS

Skunks create nauseating odors, damage lawns, harbor ectoparasites, and are subject to rabies. They may enter buildings. Entrances should be closed when the skunk is outside or it may be baited to trap outside the building for removal to a remote site.



SQUIRRELS

Squirrels of various species may enter buildings and be a nuisance or do damage to the structure. They may bite when cornered. They carry ectoparasites. Squirrels can be controlled by closing openings, by using repellents or by using live traps to remove them to remote areas. Where it is permitted, squirrels may be shot.

MOLES

Moles burrow underground and rarely come above ground. Their burrows deface lawns and they may damage the roots of ornamental plants as they search for earthworms and insects. Traps specifically designed for mole control may be useful in some situations.

SNAKES

Snakes may find their way into and around buildings. Most of them are not poisonous but may frighten humans and may bite when disturbed. Removal of food and hiding places will usually force snakes out of an area. Keep snakes from getting inside by closing all points of entry.

WEEDS

Weeds around structures may need control because:

- they create a fire hazard,
- they harbor insects or rodents, and
- they shorten the life of metal fences and buildings.

Weed control can be done by:

- Non-selective vegetation control (bare ground)—residual, broad-spectrum herbicides used to kill all plant growth and prevent new growth for a

season or more. Used where reduction of fire hazard is important.

- Short-term vegetation control—herbicides are used at rates that give a good knockdown of existing vegetation and retard the regrowth. Used where bare ground is not necessary.
- Selective weeding—control of certain plants without permanent injury to desirable plants.
- Chemical trimming and pruning—use of contact herbicides to give narrow bands of controlled weeds around desirable plants or buildings. Often used to give mowing strip around trees or under guard rails.
- Mechanical or cultural control—use of hoes, blades, fertilization, landscaping, competitive planting, or other nonchemical methods to control unwanted vegetation.

Herbicides can be applied as preemergence or postemergence treatments. A herbicide can affect plants by:

- killing the plant or plant parts that it contacts,
- killing when the herbicide is absorbed by foliage and transported throughout the plant, or
- killing when roots absorb the herbicide dissolved in soil moisture and translocated throughout the plant (may last a season or more in the soil but requires rain, irrigation, or mechanical incorporation—discing—for activation in the soil).

Factors affecting herbicide performance:

- Type of weed—all herbicides are selective to some extent and will fail to kill some types of plants. Some herbicides will work better on grasses and some will work better on broadleaf plants. Perennial weeds can often grow back from their extensive root systems and will require multiple treatments or special techniques and herbicides. Brush control may be particularly difficult but can be done in the following ways:

  Foliage absorbed—usually applied in the summer.

  Basal stem—applied to soil around stems or clumps in late winter or early summer.

  Stump treatment—application of herbicides to freshly cut stump.

  Dormant cane treatment—applications of fuel oil during winter.

- Type of soil—sand or other soil low in clay and organic matter will not absorb the herbicide as much, so lower amounts will give equivalent results. Leaching will be more of a problem. Soils high in clay or organic matter will absorb some of the herbicide. More herbicide and more rainfall is usually necessary for effective control.
- Rainfall—too much rain soon after a contact herbicide is applied can nullify its effectiveness but the same amount of rain might facilitate the action of a root-absorbed herbicide. Rainfall may also wash herbicides away from the target plants, injuring nontarget plants and animals.
- Growth stage of plant—foliage-absorbed herbicides will usually work only when the plant is actively growing. Preemergence herbicides must be applied before the weeds have emerged or a contact herbicide will have to be added to kill those that have emerged. Where selective herbicides are used, it is important that the nontarget plants be healthy.
- Sunlight—some herbicides can be nullified if they remain on the soil surface too long before a rain washes them in.

Choose equipment for the type of herbicide treatment desired.

The pump will usually be a high volume (10 gpm or more) but low pressure (50–100 lbs psi). Nozzles will usually be selected to give uniform coverage with large droplets to minimize drift. Mechanical agitation in the tank is required if wettable powders will be used.

Cooperative Extension Service, Iowa State University of Science and Technology and the United States Department of Agriculture cooperating, Charles E. Donhowe, director, Ames, Iowa. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

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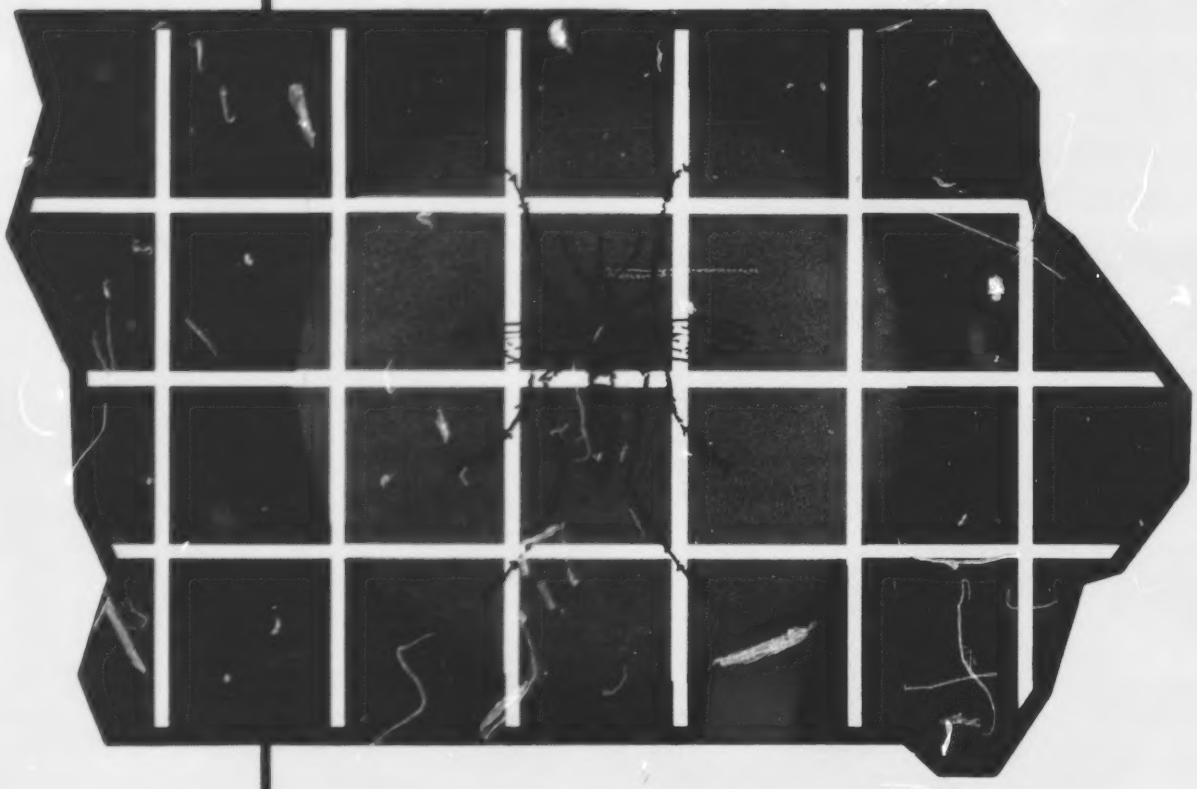
Iowa
Commercial Pesticide Applicator Manual

CATEGORY 7D

COMMUNITY INSECT CONTROL



This manual is to be used for certification training in conjunction with the U. S. Department of Agriculture – U. S. Environmental Protection Agency manual, **Apply Pesticides Correctly,** EPA-335.

Cooperative Extension Service
IOWA STATE UNIVERSITY
Ames, Iowa 50011

CS-22
September 1976 (Rev.)

This manual has been developed for individuals wishing to become certified in commercial pesticide applicator category 7D, Community Insect Control. It contains specific information that an individual must know before becoming certified in category 7D. The manual has been designed to supplement the general information contained in the core manual, Apply Pesticides Correctly - A guide for commercial applicators (plus an Iowa State University supplement) and should not be used for certification preparation without referring to the core manual as well.

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Prepared by Harold J. Stockdale and Jerald R. DeWitt, extension entomologists, and Stephen O. Ryan, former pesticide training coordinator, who express their appreciation to the University of Georgia for the use of source material.

PEST CONTROL AND PESTICIDES

Mosquitoes and flies of community health importance can be controlled by a variety of methods:

--sanitation practices
--water management
--mechanical methods
--pesticides

When mosquitoes and flies are involved in carrying a disease, in an emergency situation pesticides are usually the recommended control due to the necessity for a rapid reduction of pest populations. Nonchemical means have a preferred role in the control of many pests but are usually too slow in emergency situations. The cost of pesticides and their usually quick but temporary control must be balanced with nonchemical methods that may give much longer-lasting reductions in pest populations but may be initially more expensive.

Persons directing community health pest control programs must be able to assess their operation and determine whether they are achieving their objectives without adversely affecting man or the environment. The importance of proper survey and identification techniques has great importance in order that the applicator may select the correct control method, apply the correct insecticide at the proper time and place and keep the use of the pesticide at a minimum. Assistance in identifying pest insects can be obtained through the local county extension director's office.

Balanced pest control programs require the support of other agencies, i.e., proper garbage collection and disposal for fly control and design of impoundments and drainage ditches for mosquito control. Education of the general public and other agencies may be an essential element in getting the understanding necessary to carry out your objectives.

MOSQUITOES AND THEIR CONTROL

Life Cycle and Habitats

There are more than 43 different species or kinds of mosquitoes in Iowa. Mosquitoes have four distinct stages in their life cycle: the egg, larva, pupa and adult. The first three stages occur in water.

Each species will lay its eggs in its specific type of site. For example, some species preferring containers will lay their eggs in tree holes, tires, and various other artificial containers (cans, bottles, etc.); some species will prefer the polluted water (and others the clear water) of ditches, ponds, and lakes; and some the temporary puddles of rainwater. One fact is common to all mosquitoes: the eggs will hatch when they are in contact with water.

The larvae of all mosquitoes live in water and are called "wigglers." They strain small food particles out of water with their mouth brushes. The larvae molt four times.

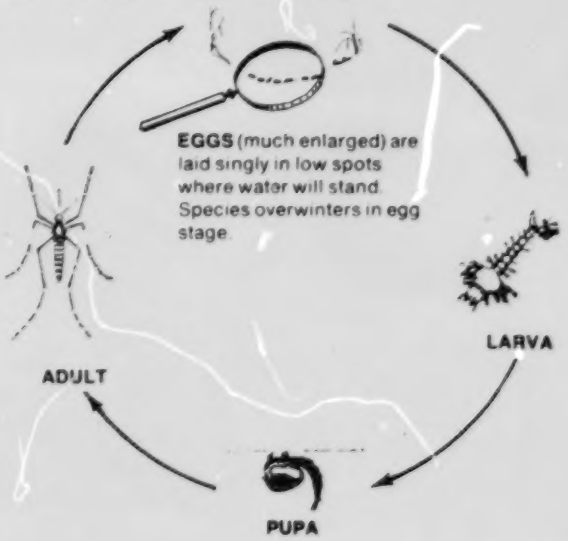
The pupae also live in the water and, unlike many insect pupae, are very active. They are called "tumblers."

After the adults emerge from the pupae, most females require a blood meal before laying eggs. Each species of mosquito prefers to feed on certain types of animals (such as birds or rodents) or even on a particular species of animal (such as horses, cattle or man). Some species of mosquito will fly only a city block or two, while others will fly as far as 10 to 20 miles. Some are active during the day, while others are active at night.

Important Iowa Mosquitoes

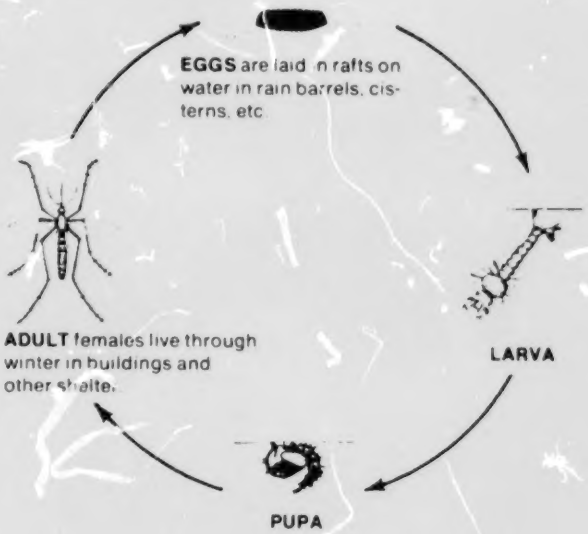
The most annoying mosquito in Iowa communities is the floodwater mosquito, Aedes vexans. The female lays her eggs individually on the soil around the edges of water in low areas. These eggs hatch when the temporary pools are flooded by heavy rains. About 8 to 12 days following a flood, mosquito adults will begin to emerge from these temporary pools, and the females will soon be seeking a blood meal.

Fig. 1. Life Cycle of **Aedes vexans** Meig.


EGGS (much enlarged) are laid singly in low spots where water will stand. Species overwinters in egg stage.
LARVA
PUPA
ADULT

A less abundant but very important mosquito because if may carry encephalitis virus is Culex tarsalis. Adult females overwinter and begin egg-laying on water surfaces, often preferring water containing large amounts of organic matter.

Fig. 2. Life Cycle of **Culex tarsalis** L


EGGS are laid in rafts on water in rain barrels, cisterns, etc.
LARVA
PUPA
ADULT females live through winter in buildings and other shelte.

When mosquitoes are causing a public health problem, it is essential to conduct a survey to identify the species involved. Knowledge of the life cycle and habitat of the species involved is essential in order that control may be directed to the proper habitat (permanent pools, tree holes, etc.) at the right time.

Public Health Importance

Mosquitoes have probably had a greater influence on human health and well-being than any other insect group. Mosquito bites are irritating and itch. Mosquitoes can interfere with outdoor activities and decrease the value of property.

There are numerous pathogens carried by mosquitoes that can cause severe illness or death to man. Most of those that once occurred in the United States (malaria, dengue and yellow fever) are no longer present. However, there is still one group that periodically appears. There are viral diseases that affect the central nervous system causing encephalitis. There are several major types of encephalitis; one found in Iowa is western equine encephalitis. This disease normally occurs in various species of birds. Mosquitoes that prefer to suck the blood of birds carry the virus from bird to bird. Other species of mosquitoes that occasionally feed on birds, horses and man will cause the disease to "spill over" into human populations. Mosquito-borne encephalitis is usually highest in late summer and fall months in Iowa.

Nonchemical Control

The application of pesticides is a never-ending cycle as long as favorable habitats are available for mosquito breeding. The initial investment in eliminating favorable aquatic breeding sites is high, but savings can be realized over time. Techniques that can be very effective in reducing mosquito populations are:

--filling
--draining
--water management
--mosquito-eating fish

In filling, draining or water management operations, expert advice should be available to prevent environmental problems. For example, filling may block drainage patterns, creating new breeding sites or interfering with aquatic life. Draining can be done in many ways; the depth of the drains, their placement and location can create more mosquito breeding plus result in changes in vegetation that affect wildlife if incorrectly done. Water management (i.e., the creation of steep banks on impoundments and ponds to reduce the area for the growth of aquatic vegetation, and fluctuating the water level to control vegetation and to allow hungry fish access to mosquito larvae) often involves other interests--fishing, recreation, water for drinking and electrical power--and these interests must be consulted. Remember, nonchemical methods have been used successfully for many years--much longer than most pesticides have been available. There is a great deal of information available to enable you to achieve your objectives and to safeguard environmental and other interests, even though compromises may sometimes be necessary.

Citizens can help a community mosquito program by preventing mosquitoes from reproducing around their homes and businesses. Cans, pails, tires, plugged eave spouts or abandoned children's toys can all hold rainwater for mosquito breeding. Junked cars, in addition to being unsightly, can furnish enough mosquitoes to annoy every citizen in a moderate-sized community. The closer to a residential area a mosquito is produced, the easier it will be for it to locate a human for a blood meal. Every community mosquito campaign should include timely news releases informing the public of the city's plans and suggesting citizen actions around their homes to help alleviate the problem.

Controlling Adult Mosquitoes with Insecticides

Various types of application equipment, insecticides and methods of application are used to control adult mosquitoes. Equipment or methods commonly used for adult control are:

--hydraulic sprayers
--mist blowers
--thermal foggers
--cold foggers
--ULV application
--aerial application
--continuous vapor dispensers

Space treatments in the form of hydraulic sprays, mists, ultra-low volume (ULV) applications and fogs or aerial applications can be very effective in quickly reducing adult mosquito populations. This is the most common control technique used when large mosquito populations become serious pests or in emergency situations such as in an outbreak of encephalitis.

Hydraulic sprayers apply about 50 gallons of a dilute course spray per acre. Some residual activity exists from hydraulic sprayer applications. Sensitive plants could be injured by some of the chemicals. This is not the best way to apply mosquito chemical to residential areas, but is excellent for park and other recreational areas. (See Table 1 for recommended insecticides.)

Table 1. Adult Mosquito Control Using Hydraulic Sprayer or Mist Blower

Product	Formulation (percent)	Amt. for 100 gal. Hydraulic Sprayer	Amt. for 100 gal. Mist Blower
Baytex	45% e.c.	1 pt.	1 gal.
Dibrom	60% e.c.	0.5 pt.	0.5 gal.
Dursban	40.8 e.c.	3 oz.	1.5 pt.
Malathion	57% e.c.	2 pt.	2 gal.
Sevin	80% S	2 lb.	10 lb.

Many communities already own a hydraulic sprayer or a mist blower for use on shade tree insect and disease control. The initial mosquito reduction would not be as great using hydraulic spray or a mist blower as it would be with foggers and airplane application. But because of the residual effect of spray and mist blower applications, very adequate community adult mosquito control can be achieved with either of these machines.

Mist blowers apply 5 to 10 gallons per acre utilizing a 100 mile-per-hour air blast to propel the tiny spray particles 125 to 150 feet from the point of discharge. Again, some residual activity exists where the spray particles land. This method works quite well in both residential and recreational areas. Communities having a mist blower for pesticide application to trees should consider using this machine for mosquito control. (See Table 1 for recommended insecticides.)

Thermal foggers produce small droplets which are effective in killing adult mosquitoes if the mosquitoes fly into the fog. Foggers should not travel over 5 miles per hour and should be applied when there is little or no wind, temperatures are above 65 degrees F, and when most mosquitoes are flying--from 15 minutes before sunset to 1 1/4 hours after sunset. The least environmental contamination would be caused by fogging, as there is no residue. Mosquitoes drifting into a fogged area minutes after the fog cleared would not be killed. Because the effective operation of a thermal fogger is so limited in time, medium to large communities should consider some other type of equipment for controlling adult mosquitoes. Two other disadvantages are that the fog can be a temporary traffic hazard and children are attracted to the fog and may want to run into it. (See Table 2 for recommended insecticides.)

In urban space spraying for mosquitoes, the city block is the unit treated. Mists are directed over the housetops while fogs are kept as near to the ground as possible. Due to their larger particle size, mists are generally more suitable for daytime use, while fogs, with much finer droplets, should be applied only when updrafts from the warm earth or water are minimal, usually mid-morning or evening.

The chief advantages of mists and fogs are:

--economy of operation.

--small amounts of pesticide are needed to cover a large area.

--large areas can be rapidly treated during emergencies.

The chief disadvantages of mists and fogs are that cars and windows may be spotted and shrubbery burned from the oil when the spraying is not done properly. Fogs are usually preferred to mist applications in urban mosquito programs due to their smaller particle size and the lower likelihood of spotting automobiles and "burning" vegetation. However, fogs can cause serious traffic hazards.

Table 2. Adult Mosquito Control Using a Thermal Fogger or Aerial Application

		Fogging mixture	Aerial mixture	
Product	Formulation	Amt. for 25 gal.	Amt. for 10 gal.	Active ingred. per acre.
Baytex	45% e.c.	2.4-3 pt.	1 qt. or 1 qt. w/water-fuel oil	0.1 lb.
	93% liq. conc.	1.0-1.5 pt.	No water (ULV)	0.1 lb.
Dibrom	14 lb. conc.	1.5 pt.	No water (ULV)	1 fl. oz.
Dursban	40.8% e.c.	0.75 pt.	1 pt.	0.05 lb.
Malathion	57% e.c.	1 gal.	1 gal.	0.5 lb.
	95% liq. conc.	0.5 gal.	No water (ULV)	6 fl. oz.
Sevin	80% S		7-10 lb.	0.5-0.8 lb.
Vapona	23.5% e.c.	1 gal.	---	---

A sludge inhibitor such as Thiosperse may be necessary to prevent insecticide fuel oil mixtures from forming a precipitate or sludge.

Cold foggers also produce small droplets which are effective in killing adult mosquitoes. Some residual effect is obtained with cold fog applications, and they can be used effectively with up to 15 mile-per-hour winds.

Cold foggers utilize a relatively new method for applying insecticides called ULV. ULV (ultra-low volume) spraying is the application of a technical grade (concentrated) pesticide utilizing a cold fogger (or with aerial application). This method eliminates excessive use of insecticides. It also reduces traffic hazards created by the thermal foggers. The amount of insecticide material used is reduced to about 1 ounce per acre. The cold fogger or ULV machine breaks down the concentrated insecticide into minute particles (about 15-20 microns). The spray is more like a "mist" than a fog. A major advantage is the application of relatively small amounts of concentrated pesticide. ULV applications are more inexpensive, since the carrier is eliminated and larger areas can be treated with a single tank of pesticide. A side benefit is that it is not as attractive for children to "run behind" the machine as they might with the thermal foggers putting out the dense smoke. (The use of concentrated or technical material, however, does increase the hazard of causing damage to automobile finishes if the particle size is not kept small enough.) Communities planning to purchase ground application equipment should investigate this relatively new method of insecticide application equipment. (See Table 3 for recommended insecticides.)

Table 3. Adult Mosquito Control
Using Ground ULV

Product	Formulation	Truck Speed	Flow Rate Per Minute	Active Ingred. Per Acre
Malathion	95% liq. conc.	10 mph	2.3 fl. oz.	.33-.5 oz.

Aerial applications can be made with fixed-wing aircraft or helicopters. Aerial applications can be applied quickly, reducing adult mosquito populations over the entire community in a few hours. Little residual control is obtained with the currently-labeled, aerially-applied insecticides. (See Table 2 for recommended insecticides.)

Aircraft can also be equipped to apply insecticides using the ULV method. The advantage to the applicator applying insecticides with ULV equipment is the small size of the payload. The helicopter or airplane has virtually no down time when applying at the rate of 1 ounce per acre. The gasoline tank would need refilling more often than the spray tank. ULV rigs must be calibrated properly to achieve proper dispersion of the insecticide and to avoid spotting car finishes. When properly calibrated and operating according to label directions, ULV applications are excellent. When the rigs are improperly calibrated and the nozzles are putting out too large droplets, the insecticide can damage car finishes and kill wildlife.

Continuous vapor dispensers are a formulation of dichlorvos in wax or resin which allows the gradual release of insecticidal vapors over an extended period of time. This type of treatment is effective against adult mosquitoes in enclosed areas such as homes, catch basins and cisterns. These vapor dispensers should not be used where infants or the aged are continuously exposed or in areas where food is prepared, served or stored.

Controlling Larvae with Insecticides

While there are three life stages of the mosquito in the water (egg, larva and pupa), most treatments (=larvicides) are directed against the larval stage. The eggs and pupae are more resistant to chemical treatment. Proper identification of the species to be controlled, knowledge of its habitat, and proper timing of applications are essential to good control.

A city employee should be responsible for locating and mapping low areas. Following heavy rains, these breeding sites should be checked for mosquito larvae and treated with one of the larvicides listed in Table 4. Use a long-handled dipper to collect larvae from flood pools. In addition, Culex breeding sites such as sewage lagoons, seepage pools and swamps should be checked throughout the summer and treatments applied when populations increase.

Table 4. Mosquito Larval Control

Product	Formulation	Amt. of Prod. Per Acre	Active Ingred. Per Acre (lb.)	Restrictions
Abate*	43% e.c.	1.5 oz.	0.05	Don't use on fish-bearing water
	2% gran.	2 lb.	0.04	Don't use on fish-bearing water
Baytex	45% e.c.	1.5 oz.	0.05	Don't use on fish-bearing water
Dursban	40.8% e.c.	1.5 oz.	0.05	Don't use on fish-bearing water
Malathion	57% e.c.	12.5 oz.	0.5	Don't use on fish-bearing water
Fuel Oil	No. 2 grade	2-3 gal.	---	Wetting agents will increase efficiency
FLIT MLO*	---	1 gal.	---	

*Larvicides not readily available. Communities planning to use these materials should contact the county extension director for the address of the company representative for these or other mosquito control products. This should be done months ahead of actual date of use.

Factors Affecting Control

The degree of pollution and amount of vegetation in the water will influence the effectiveness of pesticide applications. Heavily polluted water may require more frequent applications to maintain mosquito larvae control. Granular formulations may be preferred in heavy vegetation since they will penetrate the foliage better than solutions or emulsions. Both emulsions and oil solutions of a pesticide can be used; the latter is particularly effective in water with high organic content (or polluted). ULV aerial applications have been very successful in treating large areas under water. Petroleum oils were one of the first larvicides developed and are now again being widely used. They are effective against mosquito eggs, larvae and pupae. (See Table 4 for recommended insecticides.)

Chemical Resistance

Due to repeated applications of organochlorines and organophosphates for larvicides, many species of mosquitoes have become resistant to these chemicals. Unfortunately, a resistant larva that emerges is also a resistant adult. Since using the same pesticide for adults and larvae may cause resistance to develop faster, it is usually recommended that different chemicals be used for control of adults and larvae. It has become a common practice in many areas to use the petroleum oils for larviciding since:

--egg, larva and pupa do not become resistant to this chemical.
--environmental hazard to aquatic life is reduced.
--organophosphates and carbamate compounds can be used for adulticiding only, thereby delaying the development of resistance.

FLIES AND THEIR CONTROL

Life Cycle and Habitats

There are four stages in the life cycle of a fly: the egg, larva or maggot, pupa and adult. The larval habitat chosen by the adult female differs with different species.

Many flies (such as house flies, stable flies and deer flies) of public health interest to man lay their eggs in decaying organic matter--human garbage and waste, manure of domesticated animals, and decaying vegetation. After the eggs hatch, the larvae feed upon organic material and, in a few days to several weeks, develop into the inactive stage--the pupa. The pupal period may last from a few days to several weeks after which the adult fly emerges.

The house fly is the most common fly pest in Iowa. It develops rapidly under favorable conditions of food and temperature. The approximate length of each stage is as follows:

Egg	Maggot	Pupa	Adult to Egg-laying
8-30 hours	5-14 days	3-10 days	2-23 days

The adult fly lives about 30 days and lays a total of about 500 eggs. Its complete life cycle can be compiled in as little as 10 days.

Not all flies can bite. Some flies such as the house fly have sponging mouthparts; others such as deer and stable flies having biting or piercing mouthparts. Most flies are capable of spreading disease-causing pathogens.

It is essential that the applicator properly identify the species of fly he wishes to control. Larval breeding sites and habitats of the adult must be known in order that control efforts may be directed toward the proper target area. Some flies can fly many miles from the breeding site.

Public Health Importance

Flies, especially in large numbers, can be very annoying and seriously interfere with work and recreation activities. Biting flies (such as stable flies and deer flies) cause pain and discomfort. In addition, since flies often lay their eggs and feed on decaying organic material (garbage, sewage, waste), they can transfer disease organisms to table food which in turn is consumed by man. These may lead to dysentary, diarrhea or other illnesses.

Nonchemical Control

The removal of fly breeding sites near homes and businesses is the best method of control. This will include proper covering of garbage cans and collecting garbage at least twice a week from residences and daily from business establishments. If flies gain access to the garbage, they will be removed before a new generation reaches the adult stage.

Garbage should be buried in a sanitary landfill. Incinerators may be parctical for large cities where landfills are too remote; however, unless they are properly constructed, they may contribute to air pollution problems. Sanitary disposal of sewage and industrial wastes is essential in a fly control program. Open sewage pits and wastes from canneries, feed mills and packing houses are sources of heavy fly breeding. Adequate disposal methods should be available at the plant, or holding facilities should be available from which wastes can periodically be trucked out to a sanitary landfill.

It is essential that public health agencies secure the support of other governmental agencies that will be involved with the disposal of these wastes.

Mechanical control through screening, fly traps, electrocution devices and electric fans over doorways are additional ways that flies may be reduced. A combination of chemical and environmental sanitation methods are usually the most successful elements in a fly control program.

Controlling Adult Flies with Insecticides

Residual treatments are frequently used for adult fly control. Long-lasting insecticides are usually applied with a hydraulic sprayer to areas where flies rest (Table 5). Precipitation and sunlight, however, break down these insecticides after 1 to 4 weeks and their residual activity varies during the summer. Because flies reproduce rapidly, the constant use of long-lasting residual insecticides has tended to select out resistant individuals relatively rapidly. Adult resistance in house flies has resulted after only a season or two of use of one pesticide. Resistance may be averted by using residual insecticides only when needed and by switching to alternate insecticides.

Bait stations are a popular method of fly reduction that utilizes an attractive food plus a pesticide. They give impressive collections of dead flies near the bait station, but generally do not significantly reduce the overall population. Bait stations are at best a supplemental means of control to good sanitation and timely chemical treatments.

Controlling Maggots with Insecticides

A larvicide (Table 6) is commonly used where there are accumulations of garbage, manure, rotting vegetation or other wastes and large numbers of fly larvae. Larvicide applications, however, often do not penetrate the organic matter enough to kill the larvae. Larvicides frequently break down rapidly due to the effects of the organic matter, sunlight and moisture. Parasites and predators of the flies are destroyed, and the use of pesticides in such an environment encourages development of resistance. Sanitation practices for removing fly breeding materials is the most important aspect of fly control. It, along with chemical treatment of adults, is usually a more satisfactory program than complete dependence on chemical control.

Table 5. Residual Sprays for Adult Fly Control

Insecticide	% Concentration	Amt./100 Gal. Water
Baytex 4	1 1/2%	3 gal., 1 pt.
Cygon 2-E	1%	4 gal.
Korlan 24E	1/2-1%	2-4 gal.
Malathion 57 e.c.	1%	2 gal.

Table 6. Larvicide Sprays for Fly Maggot Control

Insecticide	% Concentration	Amt./100 Gal. Water
Cygon 2-E	1%	5 gal.
Malathion 57% e.c.	1%	2 gal.
Rabon 50 w.p.	1%	16 lb.

e.c. = emulsifiable concentrate

w.p. = wettable powder

SUGGESTED REFERENCES

Heal, R. E. 1974. Preparing for applicator certification. 3 volumes, National Pest Control Association, Inc., Washington, D.C.

National Pest Control Association. 1950-1975. Technical Releases, National Pest Control Association, Inc., Washington, D.C.

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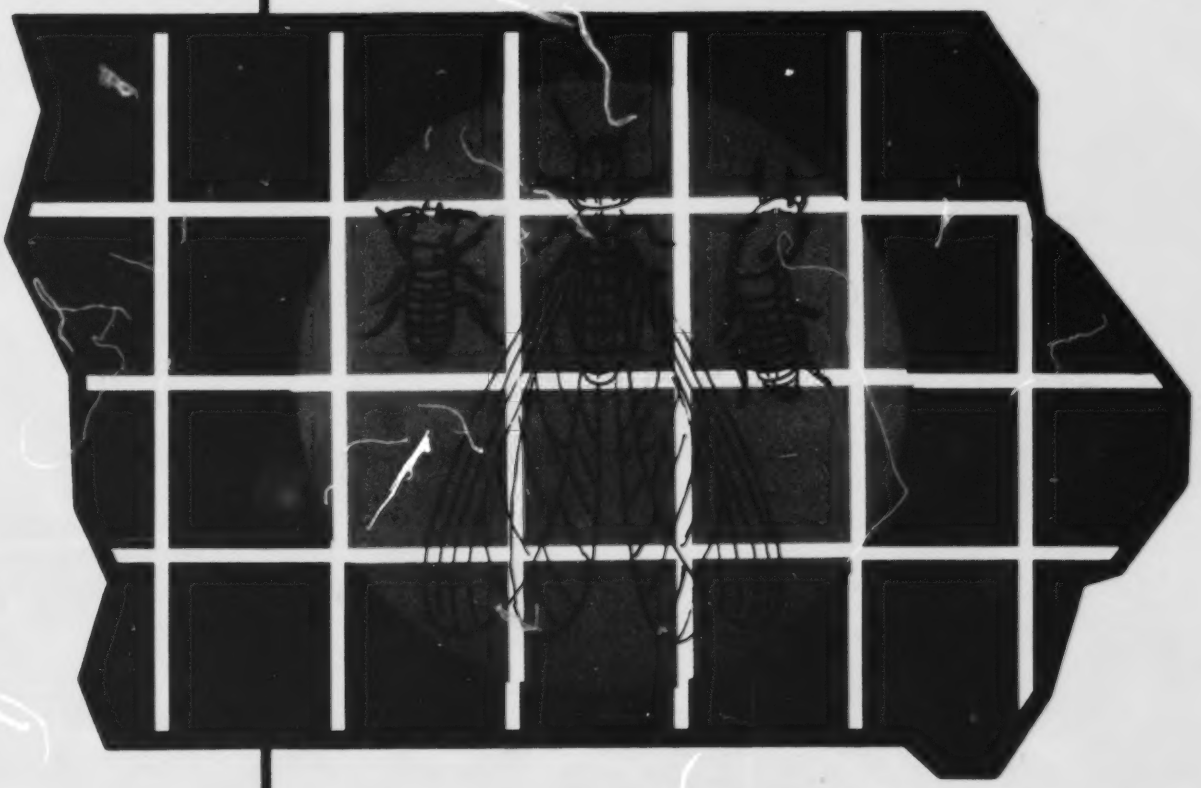
Iowa
Commercial Pesticide Applicator Manual

CATEGORY 7B

TERMITE CONTROL



This manual is to be used for certification training in conjunction with the U. S. Department of Agriculture – U. S. Environmental Protection Agency manual, **Apply Pesticides Correctly,** EPA-335.

Cooperative Extension Service
IOWA STATE UNIVERSITY
Ames, Iowa 50011

CS-20
September 1976

This manual has been developed for individuals wishing to become certified in commercial pesticide applicator category 7B, Termite Control. It contains specific information that an individual must know before becoming certified in category 7B. The manual has been designed to supplement the general information contained in the core manual. Apply Pesticides Correctly - A guide for commercial applicators (plus an Iowa State University supplement) and should not be used for certification preparation without referring to the core manual as well.

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Prepared by Harold J. Stockdale, extension entomologist, and Jerald R. DeWitt, pesticide training coordinator, who express appreciation to Purdue University for the use of source material.

INTRODUCTION

The control of termites and other structural pests is a major portion of the services of many pest control operators in Iowa. Structural pest control varies greatly from general and household pest control due to the many variables that affect the type of work done and the results of the control operation. Pest control operators who provide structural pest control services must understand not only pest identification, pest development and behavior, but also other areas of specialization. They must understand:

--building construction
--proper and safe use of pesticides
--equipment maintenance
--special hazards recognition

SPECIAL THINGS TO CONSIDER WHEN APPLYING PESTICIDES IN STRUCTURAL PEST CONTROL

After the pest control specialist has inspected and identified the pest problem, he must then determine his course of action. When a pesticide is used, he should select one that has label clearance for the intended use and one that is safe and appropriate for the job to be done. He must then decide how the pesticide is to be used:

--for a space spray, he might use an insecticide in oil.
--for long residual activity in a dry situation, a dust.
--for a residual spray, either an oil solution or water emulsion.
--for a surface application of a residual where appearance is not too important, a wettable powder.
--for use around open flames and heat, an emulsion.
--for use around electrical installations, an oil solution.
--for spraying on or around plants, a wettable powder or selected emulsion.
--for use on or around linoleum, rubber, asphalt floor tiles, and some synthetic fibers, a water-base insecticide.

Although the various formulations can be used on a wide variety of jobs in many different types of equipment, each has its own particular characteristics

which help determine which is the best to use in a given situation. (See pesticides and application equipment sections of the core manual for more detailed information.)

TERMITES

A termite is a social insect that has three stages in its life cycle--the egg, nymph and adult.

Eggs--The eggs are laid in small cells by not only the primary queen but also secondary reproductives.

Nymphs--The nymphs or immature termites hatch from the eggs and molt several times. They eventually change or develop into various forms or castes.

Adults--The adult termites are composed of four castes: workers, soldiers, winged or primary reproductives and secondary reproductives.

Cast Identification

Workers--The most numerous individuals in the colony are the workers. They are 1/4 inch long, white, wingless, soft-bodied and blind. They perform the work of the colony and cause the destruction of wood which makes them of economic importance.

Worker Soldier

Reproductive

Soldiers--The members of this caste protect the colony from its enemies. Soldiers are 1/4 inch long and have large heads and jaws.

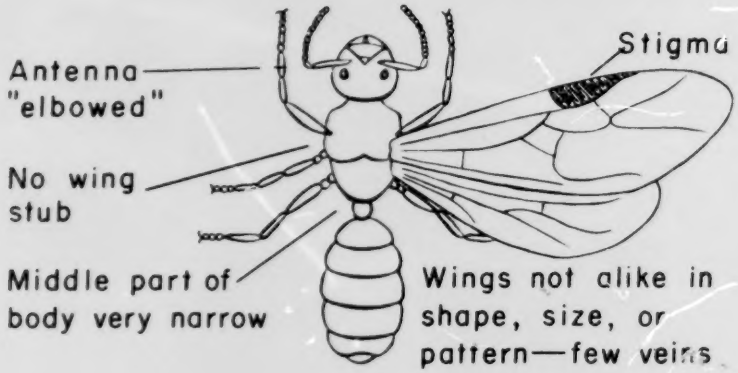
Primary Reproductives--These are the winged, swarmer termites observed by householders. Primary reproductives and 1/2 inch long, black, thick-waisted and have four wings of equal length.

Secondary Reproductives--These forms are 1/2 inch long, white and wingless (or have very short wings).

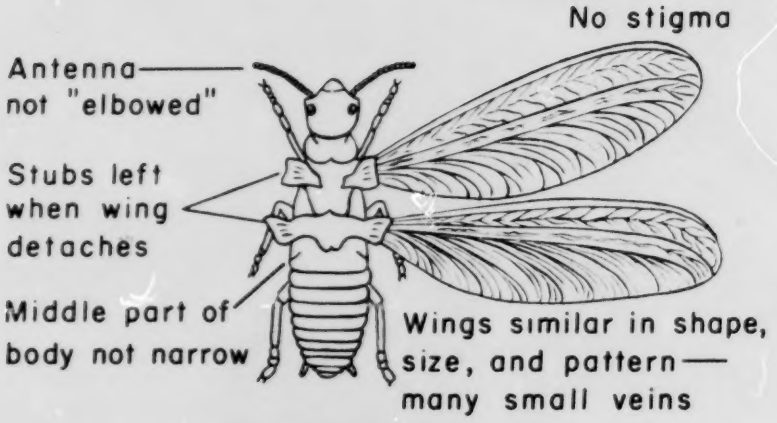
Termites are social insects that live in colonies of one million or more individuals. The original or primary queen attains maturity in about two years. Although worker and soldier termites may live only two to three years, the primary queen may live as long as 25 years.

Swarming

Both male and female reproductives leave the colonies in great numbers in April and May in Iowa. Often this is the first indication that is observed by the homeowner. Generally, termites swarm on warm, sunny days when the humidity is high. After a brief flight, the wings are broken off and the termites pair up and attempt to establish a new colony. Most are unsuccessful at this time. Each successful pair makes a small cell in the soil, mates, lays eggs and begins a new colony. Swarmer termites are often confused with flying or winged ants. Ants frequently swarm around buildings also. It is important to be able to distinguish the difference between swarmer ants and termites so that correct control measures can be taken.



ANT


No stigma
Antenna not "elbowed"
Stubs left when wing detaches
Middle part of body not narrow
Wings similar in shape, size, and pattern—many small veins

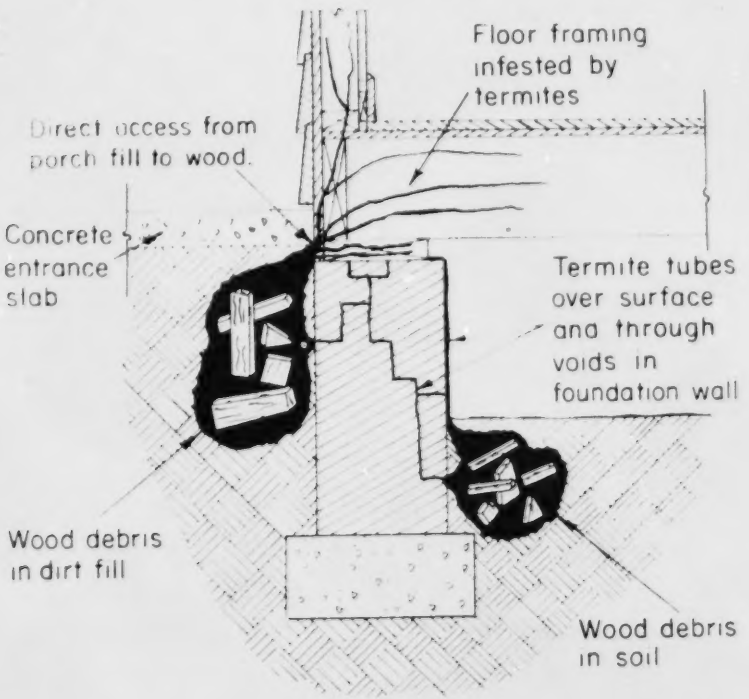
TERMITE

Subterranean Termites

The eastern subterranean termite, Reticulitermes flavipes (Kollar), is the most common termite in Iowa.

--So named because the colony extends below ground with the workers attacking wood above ground.
--White, soft-bodied workers eat the soft grain of wood, leaving a thin shell outside and the harder portion in layers.
--They use bits of soil and excrement to build shelter tubes and to close up breaks in the surface of infested wood.
--If "swarmer" (reproductive) termites have not been seen, the presence of a colony can be determined by probing wood near the foundation or soil or by observing earthen "shelter tubes" on foundation walls or wood.

This termite must have wood for food and usually needs soil for moisture. Wood in contact with soil is ideal for termite development. However, termites may build shelter tubes across foundation walls and other surfaces between the


Floor framing infested by termites
Direct access from porch fill to wood.
Concrete entrance slab
Termite tubes over surface and through voids in foundation wall
Wood debris in dirt fill
Wood debris in soil

Termites may enter structures from buried wood.

wood and the soil. Termites occasionally become established without soil contact when a leaky roof or pipe provides moisture. Infestations may become established under concrete slabs, garage floors, patios and filled dirt porches where wood is buried. Termites may then enter the building through structural wood or foundation walls adjacent to the slab. In houses built partly or completely on slabs, termites enter through expansion joints, cracks, and utility openings.

Breaking the connection between wood and soil is essential in termite control. This may be done with either a chemical or mechanical barrier.

Inspections for Subterranean Termites

When a pest control operator is called to a building in which a subterranean termite infestation is suspected, it may be difficult to determine whether or not termites are actually present. The pest control operator must be knowledgeable about termites and their habits in order to accurately detect their presence. He must also be able to recognize signs of damage or an infestation and be able to evaluate the extent of an infestation if one occurs.

In making a termite inspection, a good, bright flashlight is essential. Trouble spots must be looked at closely and inspectors must crawl into most spaces and under nonbasement areas. For this part of his work, a pair of coveralls will protect his normal clothing. Infested structures must also be measured accurately. A steel tape, yardstick or other measuring device is mandatory in making an inspection. An infestation of termites may be indicated by:

--presence of swarmers
--accumulation of shed wings
--presence of mud tubes
--mud between cracks in boards
--damaged wood
--hollow sounding wood when tapped, or
--presence of live termites

Subterranean termites are usually found at or near ground level. Seldom do they occur above the level of the first floor windows.

Treatment of Subterranean Termites

The pest control operator's basic objective in termite control work is to develop a barrier between the termite nest, usually in the ground, and its food--the wood. This barrier is usually of chemical or mechanical nature. A complete treatment involves the following basic steps:

--mechanical alteration
--soil treatment
--foundation treatment
--wood treatment

Any given termite control job may involve one, several, or all of these steps. In many situations, an adequate job may be performed without involving all four types of treatments.

Mechanical alteration involves modifications of structures such as using concrete or metal barriers that may prevent the entry of termites. Removing wood debris, eliminating moisture and establishing ventilation are also helpful.

Soil treatments consist of chemical applications to soil under and adjacent to a building in order to create a chemical barrier that the termite cannot penetrate. Soil treatments should be made around utility entrances (electrical, water, sewage, etc.), under slabs and inside and outside the foundation.

Treating slab-constructed buildings involves saturating much of the soil beneath the slab. The chemical is injected either:

--through holes drilled in the slab at 12- to 16-inch intervals next to all foundation walls, cracks in the slab and utility openings, or
--by drilling and rodding horizontally through the foundation wall from outside the building to reach the same key areas.

Either method must be carefully executed since heat pipes, vapor barriers, etc. may be located under the slab. If treating by the first method, insecticide should be applied at the rate of 4 gallons per 10 linear feet. If saturating beneath the slab by the second method, the insecticide rate is 1 gallon per 10 square feet.

Filled porches are treated one of two ways:

--the slab can be drilled from the top as described above or the porch foundation drilled horizontally at each end next to the building, and the chemical injected by rodding, or

--openings in the foundation wall can be made and the porch fill excavated immediately under the slab next to the building foundation and the soil treated with chemical at 4 gallons per 10 linear feet. Also spray the fill surface, the foundation wall and undersurface of the slab.

Foundation treatments consist of applying the chemical into and adjacent to the foundation in order to prevent entry of the termites. The chemical is injected into cracks at the footing and through cracks in the wall leading to the ground outside.

Soil on both sides of exposed foundation walls and soil surrounding supports should be soaked down to the foundation footing with an approved termite control chemical at a rate of 4 gallons per 10 linear feet per foot of depth. Application is made by trenching or a combination of trenching and rodding.

For outside basement walls (where the footing is deep) a V-shaped trench is dug against the wall. It should be at least a foot deep, or deeper, if necessary to insure penetration to the footing. After trenching, a perforated hollow rod should be used to inject insecticide to the footing of the basement wall at the rate mentioned above. When treating concrete block or brick foundation walls, they should be drilled above the grade line and all voids flooded with 2 gallons of insecticide per 10 linear feet.

Wood treating eliminates existing termite infestations or makes wood unacceptable for later termite infestations. The above-mentioned three methods are usually used in termite control along with wood treating as a pretreat or supplemental measure. Pressure-treated wood is often used in the construction of the first floor and gives effective control. Surface spraying rarely penetrates the wood. In severely damaged wood, chemicals can be injected into the termite cavities.

Chemicals for Termite Control

Four chemicals are currently recommended for subterranean termite control in Iowa. They are 0.5% aldrin, 1% chlordane, 0.5% dieldrin and 0.5% heptachlor. The main function of the volume of liquid placed into the soil or structures is to distribute the correct amount of pesticide properly. The important point in soil treatments is to saturate the area being treated. Some soils do not accept chemicals as readily as others, and the depth of footings occasionally varies.

DRY-WOOD TERMITES

Dry-wood termites:

--Directly attack wood and make galleries in it rather than below ground.

--As they feed, they cut across the ligneous grain of wood, excavating large galleries which are connected by small tunnels.

--They produce hard fecal pellets with six distinct concave surfaces on the sides. These pellets are often pushed out of the infested wood through small holes.

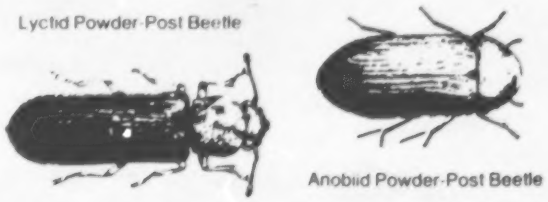
Drywood Termite Fecal Pellets

Control dry-wood termites by fumigating the entire structure with a toxic gas, using a gas-tight tarpaulin. Control small, localized infestations by injecting insecticides through holes drilled into the termite galleries. Furniture and other movable objects may be fumigated in special chambers.

POWDERPOST BEETLES

Although there are several kinds of powderpost beetles, the most commonly encountered ones fall into two groups, the Lyctid powderpost beetles and the Anobiid powderpost beetles. The adults are small (about 1/5 inch long) and are usually reddish-brown to nearly black. They all damage wood in about the same manner and require the same control measures. The surface of infested wood

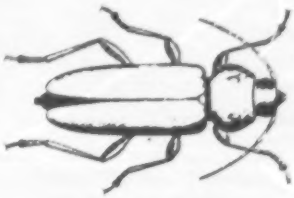
is perforated with numerous, small "shot holes," each about the size of a pencil lead. Any slight jarring of wood causes a fine powder to sift from these holes. When cut or broken, the interior of infested wood may reveal masses of this finely-packed powder which is produced by the feeding of grub-like larvae. Joists, sub-flooring, hardwood flooring, sills, plates and interior trim are the parts of buildings most frequently attacked. In addition, furniture and other wood products may be damaged.



Treatment involves spraying infested wood with an approved residual insecticide. All surfaces being treated must be thoroughly wetted for effective control. Chamber fumigation is often used for furniture and other movable objects.

LONG-HORNED BEETLES

Long-horned beetles are large (1/2 to 3 inches long), conspicuous beetles with long, thin antennae which may be longer than the body. Eggs are usually laid on unseasoned, rough-sawed timbers or logs, and the larvae, called round-headed borers, feed on the wood. The larvae bore large, oval-shaped holes as they move through wood. The only species that will attack timbers in a building is the old-house borer and, therefore, is the only one requiring control measures. The adult is about 3/4 inch long, grayish-brown to black with two white patches on the elytra. Damage is usually limited to pine sapwood and can be recognized by ripples on the surface of the galleries.


Old House Borer

If the old-house borer is to be controlled, infested timbers must be drilled and pressure-treated to force the toxicant throughout the gallery system. Only in this manner can the larvae be killed, since they may be considerable distances from the obvious points of infestation. In some cases, tarpaulin fumigation may be required.

ANTS

Ants can be a problem in and around the home and other structures. Most species build their nests in soil. Those that invade buildings usually nest near foundation walls or under concrete slabs. One species, the carpenter ant, builds its nest in hollow trees, stumps, and sometimes in the timbers of buildings.

During the year, ant colonies produce winged individuals. These are often mistaken for termites. However:

--ants have a narrow "waist" like a wasp; termites a straighter body and no waist.
--ants have two pairs of wings of unequal length; termites have two pairs of wings of equal length.
--ants have elbowed antennae; termite antennae are straight.

Carpenter Ants

Carpenter ants:

--Variable in size, measuring up to 1/2 inch long.
--Red to black in color.
--Either winged or wingless.
--Construct their nests in hollow trees, logs, telephone poles, poles, posts, porch pillars and other timber used in homes.
--Trademark is a small pile of course sawdust usually containing insect fragments, beneath their nesting site. These nests are usually found in wood with a "higher than normal" moisture condition.
--Does not consume wood, but simply hollows it out to form nests.
--Can weaken building structures.

The secret to the control of ants, whether they be carpenter ants or other indoor or outdoor nesting ants, is direct treatment of the nests. In the case of carpenter ants, look foor the piles of sawdust to locate the entries. Then blow dust into the nesting area. Other species may nest in soil around the foundation or out in the lawn. These can be controlled by applying an approved emulsion, wettable powder, or granular form of insecticide directly to the nest and surrounding area.

Houses built on concrete slabs often have serious ant problems. The insects nest under the slabs and enter through cracks, heating ducts and utility openings. Here, again, it is important to locate and apply insecticide to the nest.

However, if ants still get into the house, apply insecticides where the ants gain entry or hide--at foundation walls, doorways, windowsills, baseboards, behind built-in cabinets and furniture, beneath refrigerators, and other heavy appliances. Residual sprays in the areas usually work best, although dusts may be more appropriate in some areas.

WOOD DECAY FUNGI

Decay will occur only in wood having a moisture content greater than 20 percent. Most decay or rot fungi grow only on wood which is subject to wetting by contact with moist soil, rain, plumbing leaks, or condensation. Two rare species, however, can conduct water directly to wood. Decay fungi, which are living plants that take their food from the wood as they grow, reduce the strength of wood, often making it brown and crumbly or white and stringy. Discoloration and powdery growth on wood should not be confused with decay. If the moisture content of the wood is not obvious, it must be measured with a moisture meter to accurately determine the need for treatment.

Wood Decay

The use of fungicides or insecticides alone will not stop wood decay once it has started though it will slow its progress in some cases. The key to the complete control of wood decay is to eliminate the source of moisture if possible through proper drainage, breaking wood-soil contact, ventilation, the use of vapor barriers, and other good construction practices. If moisture is a chronic problem construction lumber should be commercially pressure-treated with preservative chemicals.

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Iowa
Commercial Pesticide Applicator Manual

CATEGORY 7C

FOOD INDUSTRY PEST CONTROL

This manual is to be used for certification training in conjunction with the U. S. Department of Agriculture – U. S. Environmental Protection Agency manual, **Apply Pesticides Correctly,** EPA-335.

Cooperative Extension Service
IOWA STATE UNIVERSITY
Ames, Iowa 50011

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Edited by Jerald R. DeWitt, pesticide training coordinator.
Appreciation expressed to the University of Minnesota for use of source material.

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INTRODUCTION

The control of pests in food plants (food manufacturing, processing, and warehousing) requires a high degree of professionalism combined with experience and knowledge.

- Food plants must continually employ pest management programs.
- These programs must be directed against pests in the immediate area, and against pests that may be introduced from incoming materials.
- These programs must respond to daily needs and be flexible to meet emergency pest control situations.
- Without good pest management, contaminated products may result. Contamination can cause serious health, financial, legal, and aesthetic problems.

PESTS

A variety of pests are found in food manufacturing plants. The type of pest you will find depends on both the geographic location of the plant and the type of food being processed.

Pests may damage, destroy, or contaminate processed foods. They must be controlled to protect the quality of the product. The presence or evidence of pests may result in seizure of products or other actions by Federal or State agencies.

INSECTS

Cockroaches

Cockroaches contaminate food with their droppings, with their bodies, and with bacteria they carry. They vary somewhat in appearance and habits, but in general:

- All cockroaches have chewing mouthparts.
- They seek cover in the daytime or when disturbed at night.
- All are flat, brownish or dark, and fast-running.

The stages in the life cycle of a cockroach are:

- the egg, enclosed in a capsule which contains several eggs,
- several stages of nymphs, which look like the adults but are smaller and have no wings, and
- the adult.

AMERICAN COCKROACH:

- Adults have wings covering the entire abdomen.
- Reddish-brown.
- Adults 1 to 1½ inches long.
- Found in dark, moist areas and may live in sewers.

GERMAN COCKROACH:

- Adults have wings covering entire abdomen.
- Tan with two dark stripes running lengthwise on the area just behind the head.
- Often occur in large numbers.
- Will eat almost any food consumed by man.
- Adults 1 to 1½ inches long.
- More active than other cockroaches.

ORIENTAL COCKROACH:

- Female has small wings; male's wings cover about ¾ of the abdomen.
- Shiny black, or very dark brown.
- About 1 inch long as an adult.
- Often lives in sewers and enters buildings through drains.

German Cockroach

American Cockroach

Oriental Cockroach

Stored Product Pests

Beetles are important pests of stored food. Usually both the larva and the adult will feed on foodstuffs. Under ideal conditions they can have six or more generations per year and quickly become a serious problem. Adults may have a pair of thin wings covered by a pair of thick, hard wings.

The stages in the life cycle of the beetle are:

- egg,
- larva,
- pupa, and
- adult.

RICE WEEVIL—GRANARY WEEVIL:

- About ⅛ inch long; dark brown.
- Pronounced snouts.
- Larvae are small, white, legless grubs that feed and develop inside individual kernels of grain.
- May attack grain prior to harvest and in storage.
- Rice weevil can fly; granary weevil cannot fly.

Granary Weevil Rice Weevil

LESSER GRAIN BORER:

- Shiny dark brown or black beetle.
- Small and slender.
- Head turned downward; very strong mouthparts which can cut through wood.
- Adult is a strong flier.
- Larvae feed on flour, grain dust, or broken or whole grain.

DRUGSTORE BEETLE—CIGARETTE BEETLE:

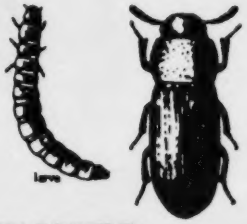
- Small, reddish-brown adults, usually less than ⅛ inch long.
- Head on adult bent down and not visible from above.
- Feed on dried plant and animal material.
- Cigarette beetle can fly; drugstore beetle seldom flies.
- Wing covers lined on drugstore beetle; smooth on cigarette beetle.

Cigarette Beetle

Drugstore Beetle

CONFUSED FLOUR BEETLE—RED FLOUR BEETLE:

- Elongated, flat adults, about ⅛ inch long.
- Shiny, reddish-brown.
- Feed on stored foods such as flour, cereal, nuts, and spices.
- Feed by scraping the surface of foods or eating finely ground material.
- Red flour beetle is a strong flier; confused flour beetle cannot fly.
- The three segments at the tip of the red flour beetle's antennae are enlarged. The antenna segments of the confused flour beetle enlarge gradually toward the tip.



Red Flour Beetle

SAWTOOTHED GRAIN BEETLE—MERCHANT GRAIN BEETLE:

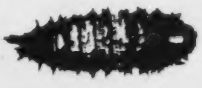
- Elongated, flat adults, about ⅛ inch long.
- Dark brown.
- Adults have sawtooth-like projections on sides of area just behind the head.
- Do not fly.
- Feed on almost all dried foods.

Saw-Toothed Grain Beetle

DERMESTID BEETLES:

- Oval-shaped beetles which feed on waste grain or flour.
- Natural scavengers.
- Several species.
- Larvae are tapered, with head at the large end.
- Prominent bristles or hair often found at pointed end of larva.
- Larvae feed on dry grain dust, waste matter, or flour.

Khapra Beetle Adult



Khapra Beetle Larva

Moths cause damage by:

- eating food,
- contaminating food to the point where it cannot be consumed by humans, and
- webbing food with so much silk that mill machinery may be clogged. Large populations may lead to microorganism problems.

The stages in the life cycle of the moths are:

- egg,
- larva,
- pupa, and
- adult.

ANGOUMOIS GRAIN MOTH:

- Adults have four wings; about ½ inch wingspread.
- Forewings are pale yellow. Hind wings are gray and pointed.
- Larvae develop within whole kernels of grain.
- May attack grain before harvest as well as in storage.
- Pupa found inside grain.
- Six to seven generations per year.
- When they emerge, they leave a round flap over the hole in the grain.

Angoumois Grain Moth

INDIAN MEAL MOTH:

- Adults have four wings, with a wingspread of about ½ inch.
- Forewings have a coppery color on the outer two-thirds and whitish gray near the body.
- Larvae spin large amounts of silk in and over food.
- Larvae may leave food and crawl over adjacent surfaces.
- Five to six generations per year.
- Prefers flour but feeds on many raw and processed dry foods.

Indian Meal Moth

MEDITERRANEAN FLOUR MOTH:

- Adults have four wings, with a wingspread of about ¾ inch.
- Front wings are gray with dark wavy lines.
- Adults rest with head and thorax held high.
- Larvae feed on surface of food, and spin large amounts of silk in and over it.
- Three to four generations per year.
- Larvae leave feeding area to pupate.
- Prefers flour but infests wheat, bran, nuts, chocolate, seed, beans, and dried fruits.

Mediterranean Flour Moth

WAREHOUSE MOTH:

- Adult's forewings are gray.
- They fly in a series of quick darts.
- Habits similar to the Mediterranean Flour Moth.
- Larvae striped with a series of brown or purple dots.

Domestic Flies

Most flies have one pair of wings as adults. The larvae are called maggots and have the head at the small pointed end of the body. Larvae have no legs.

The life cycle of the fly includes:

- egg,
- larva,
- pupa, and
- adult.

BLUE BLOW FLY:

- Area behind the head gray with stripes. Abdomen shiny blue.
- Slightly larger than housefly.
- Common during early spring.
- Life cycle is 2–3 weeks.
- Attracted to decaying flesh.

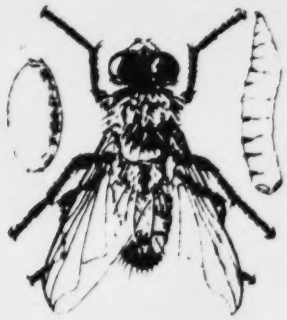
GREEN BLOW FLY:

- Body shiny green or copper.
- Slightly larger than housefly.
- Garbage is common breeding area.
- Often comes from nearby residential areas or farms.
- Life cycle is 9–18 days.
- Common during summer months.

HOUSEFLY:

- Adults dull gray with four stripes on area behind the head.
- About ¼ inch long as adult.
- Most abundant in fall, but may be found throughout the year.
- Larvae occur in animal waste or rotting fruits and vegetables.
- Life cycle is 1–6 weeks.

House Fly



FRUIT FLY (VINEGAR FLY):

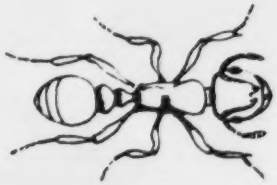
- Adults about ⅛ inch long and yellowish brown.
- Attracted to sour or pungent odors.
- Adults often found around overripe fruit or vegetables.
- Life cycle is 8–11 days.
- Eggs often laid on cracks in tomatoes and similar foods.

Occasional Pests

ANTS:

- Only adults are normally seen.
- Eat many foods but prefer sweets and grease.
- Most species have winged stage once a year.
- Most come in from outside, but a few species nest in walls.

Ant



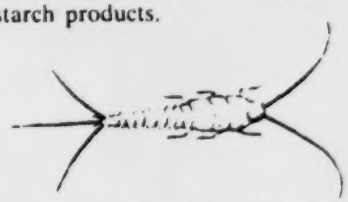
The stages in the life cycle of an ant are:

- egg,
- larva,
- pupa, and
- adult.

BRISTLETAILS (SILVERFISH, FIREBRATS):

- Gray, silver, or brownish adults, about ½ inch long.
- Young resemble adults but are smaller.
- Silverfish like high humidity; firebrats prefer low humidity and high temperature.
- Can live a year or more without food.
- Often found in warehouses, where they may damage paper and starch products.

Bristle Tail



The stages in the life cycle of silverfish and firebrats are:

- the egg,
- nymphs, and
- adult, which continues to molt throughout its life span.

BOOKLICE (PSOCIDS):

- Very small ($\frac{1}{50}$–$\frac{1}{10}$ inch).
- Young resemble adults.
- Normally live in moist areas and feed on fungi.
- May be carried into food manufacturing plants on infested pallets and cardboard slipsheets.
- Have been found in newly manufactured empty containers.

Booklouse

Life cycle takes a little over a month. The stages are:

- egg,
- nymph, and
- adult.

CRICKETS:

- Winged adults are attracted to lights in summertime.
- May stray into food manufacturing plants and contaminate food.
- May eat holes in paper, cloth, or rubber.
- Large hind legs adapted for jumping.

Stages in the life cycle are:

- egg,
- nymphs, and
- adult.

SPIDERS AND MITES

- Spiders are usually just a nuisance, but the black widow and brown recluse are poisonous.
- Spiders are more commonly found in warehouses than in production areas.
- Webs, bodies, and excretions of spiders can be a nuisance.
- Presence of spiders may indicate an insect infestation problem.
- Mites are extremely small.
- Some mites contaminate food.
- A heavy infestation of mites produces a pronounced pungent odor.
- Mites may cause skin rash to humans and digestive disturbance if eaten.

CENTIPEDES

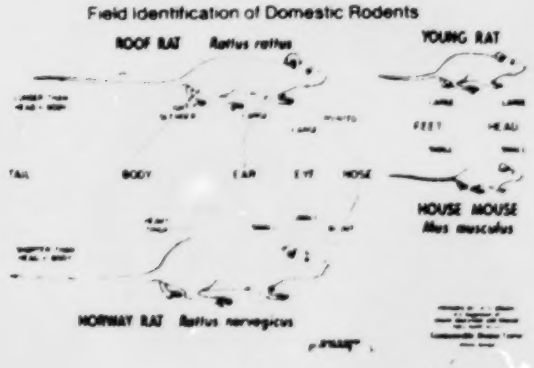
- Has many legs—one pair per segment.
- Beneficial and eats insects, but may contaminate food.
- Large populations are associated with moisture and decaying vegetable matter.
- May enter from outside.
- May frighten some workers, but not poisonous.

RODENTS

- Contaminate and destroy food products.
- Damage equipment, structures, and other nonedible items.
- May carry diseases and ectoparasites.
- Can cause fires.
- Have the ability to coexist with man.

The three most common kinds are:

- Norway, brown, or common rat,
- roof or black rat, and
- house mouse.



The Norway rat prefers to live in underground burrows, but can climb readily. The roof rat prefers to live in upper portions of a building, but may use burrows. The house mouse lives in any convenient protected space inside or outside.

BIRDS

Only three species of birds—English sparrows, pigeons, and starlings—are normally considered pests around food manufacturing plants. They are primarily objectionable because:

- Their feathers and droppings can contaminate food.
- They may spread diseases.
- They may ruin roofs and gutters and deface buildings with their droppings.
- They sometimes carry mites which can bite man.

PEST CONTROL

INSECTS

Cockroaches

Continual removal of food and water sources and destruction of breeding places are essential in obtaining satisfactory cockroach control. Apply insecticides as crack and crevice or spot treatments to places where the insects hide. Follow label directions for commercial food handling areas.

Common hideouts are behind and beneath built-in equipment, beneath trash, in floor drains, sewers, and in cracks and crevices in concrete, brick, or block walls. Sprays are usually preferred to dusts because they are easier to apply and the residue is not visible. Dusts, however, can sometimes be blown into places difficult to reach with spray.

Use ULV (ultra low volume) concentrates and aerosol applications of contact sprays and flushing agents to supplement residual sprays and dusts. Use them alone where the label prohibits use of residuals.

Stored Product Pests

To eliminate infestations, find and destroy infested materials and treat the area where they are stored. Some infested materials can be treated with cold or heat or fumigated. Thorough cleaning is essential to remove spilled food to prevent reinfestation.

Domestic Flies

Successful fly control must include a combination of sanitation measures, mechanical lures (electric grids), physical barriers (screens or air curtains), and insecticides. The plant and surrounding area should be kept free of garbage, manure, and decaying plant or animal matter. Continual removal of solid and liquid process wastes is essential to prevent the formation of breeding sites. Control adults by spraying resting places with the use of aerosols or ULV concentrates. Baits can be used to treat breeding sites.

Ants

Control ants by direct treatment of their nests. Dusts can be used on outdoor-nesting ants. For control of indoor-nesting ants, use formulations that will not move far from the spray site. Follow label directions. Sprays or granular insecticides can also be used on the nests and surrounding area. If you cannot locate the nest site, apply insecticides where the ants gain entry or hide—along foundation walls, at doorways, windowsills, baseboards, or behind or beneath equipment.

Bristletails

Directed sprays applied to cracks and crevices that serve as hiding and resting places are most frequently used for control; dusts and baits may also be used as well as aerosols and ULV concentrates.

Booklice

Remove moisture and food sources. Directed sprays and aerosols are effective in control.

Crickets

Remove trash piles and tall weeds. If a dump or similar area is a breeding place, cover it with 6 inches of soil or ashes. Outdoor sprays give only temporary control. Inside, spray residual pesticide in areas where crickets have been seen.

SPIDERS AND MITES

Control insects that serve as food, and remove webs. Direct pesticide sprays or dusts at hiding areas.

CENTIPEDES

Remove sources of moisture and decaying vegetable matter. Use wettable powders or emulsifiable concentrates of residual pesticide in a 2- to 3-foot strip around the outside of the building. Treat suspected breeding sites by applying the pesticide with enough water to carry it down to where the pests live.

RODENTS

A rat or mouse control program is based on knowing:

- where they live, feed, and travel, and
- the extent of the infestation.

You must eliminate shelter, food, and water. Close all entrances the rats or mice use to come and go from buildings. These preventive measures are the key to successful control. To prevent rodent migration, it is best to poison or trap before making environmental changes.

The two categories of rodenticides are:

- multiple-dose anticoagulants, and
- single-dose poisons.

Each rodenticide has special characteristics, uses, and hazards. Some are highly toxic to humans and pets. Mix, handle, and apply them according to label directions.

Place bait deep into burrows or use bait stations. Keep them away from people and desirable animals. Dispose of excess baits and dead animal carcasses at frequent intervals.

Mice will eagerly sample new food. Rats, however, usually approach new food with caution. If it tastes bad or makes them sick, they will not eat it again. This is "bait shyness". When using bait for control, use a bait that is fresh and identical to the food the rats are using. If you use a different bait base, prebait in the area for a few nights before using a toxic bait. Alternate anticoagulants with single-dose poisons to reduce possibility of the development of resistance. Certain baits may attract insects and should be replaced often.

Rats require water to drink. Mice may get water from the food they eat. If all water sources can be eliminated, liquid baits are very effective for rats but only moderately so for mice.

Both rats and mice prefer to run next to walls or other surfaces. Place traps and baits in these runways. Traps may be used with bait, or the trigger

device may be expanded and used without bait. Rats approach new objects cautiously.

The mouse investigates any new object or change in its territory, so changing placement of baits or traps may improve control. Each house mouse establishes a territory which may not extend more than 10 feet from the nest. For this reason, baits and traps should be placed no more than 10 to 20 feet apart.

Be aware of nearby environmental disruptions that may cause rodents to enter buildings.

BIRDS

Sanitation is the first step in control. Remove food, water, and habitat. Control methods include building out, removing food, and using repellents, traps, or avicides.

Building out involves using new construction features or modifying existing features so that birds cannot roost or nest.

Repellents include various devices or substances installed in potential bird roosting and nesting areas. They include revolving lights, noise makers (distress calls), charged wires, and repellent glues or jellies.

Traps are often used successfully in pigeon control, especially when prebaited for a few days. Release any birds that are protected by law from such control methods.

Population reduction includes shooting (where permissible) and the use of avicides. Chemical control is probably the most effective method. Follow label directions closely. Know your city, county, State, and Federal regulations.

PEST TREATMENT AREAS IN FOOD PLANTS

Food plants have five areas of activity where pests must be controlled:

- receiving and storage area for incoming materials,
- processing area,
- packaging area,
- finished product warehouse and shipping area, and
- grounds—the building exterior and the area around the plant.

Both chemical and nonchemical controls are important in these areas. Nonchemical controls include both preventive maintenance and mechanical and physical measures.

Pests may enter the plant in two ways:

- by slipping by the outside control programs, and
- by coming in with ingredients or materials.

Some nonchemical control methods that apply to all areas inside a plant are:

- Rodent-proofing and bird-proofing doors, walls, windows, and roofs.
- Screening all windows that can be opened.
- Eliminating cracks, crevices, and other places where pests may hide.
- Whenever possible, locating equipment off the floor and away from walls or sealing it to walls and floors.
- Keeping the building clean and free of litter.
- Keeping the inside and outside of all equipment clean.
- Using light traps for insects.

INCOMING INGREDIENTS AND MATERIAL STORAGE AREAS

Nonchemical Controls

- Visually inspect all vehicles, ingredients, and materials to insure that pests are not brought into storage areas.
- Store ingredients and materials far enough away from walls to permit access for inspection.
- Use FIFO (first in-first out) rotation of incoming materials.
- Use traps or other methods for rodents.
- Use air curtains at dock and pedestrian doors to keep insects out.
- Use mechanical repellents for birds.

Chemical Controls

INSECTS:

- Space treatment with nonresiduals.
- Crack and crevice treatment with residuals.
- Spot treatments with residuals.
- Periodic general treatment.
- Treatment of raw bulk commodities with fumigants and sprays on receipt and during storage where applicable.

RODENTS:
- Bait stations.

PROCESSING AND PACKAGING AREAS

Nonchemical Controls

- Place rodent traps near doors if situation warrants.

Chemical Controls

INSECTS:
- Space treatment with nonresiduals.
- Spot treatment with nonresiduals.
- Crack and crevice treatment with residuals.
- Contact treatment with nonresiduals.
- Periodic general treatments.

FINISHED PRODUCTS WAREHOUSE AND SHIPPING AREAS

Use the same pest control methods in the finished products warehouse as in the materials receipt and storage area.

Vehicle inspection is essential to prevent the finished products from being placed in a pest-contaminated carrier. Vehicle inspection is difficult, particularly for boxcars and trucks with false walls or endliners. If vehicles are dirty or infested, do not use them.

Chemical Controls in Vehicles

Before loading, consider:
- space treatment, or
- crack and crevice treatment.

After loading, use:
- general treatment—usually a solid fumigant—for in-transit control.

GROUNDS

Nonchemical Control

- Eliminate all exposed dirt surfaces by paving all roadways or parking areas and maintaining well-kept lawns. This will reduce contamination from dirt, microbes, and other airborne particles.
- Provide good drainage to help keep the area clean and dry.
- Place outside lighting away from buildings and focus the lights toward buildings. This helps keep night-flying insects away from doors and windows.
- Screen potential bird roosting areas.
- Store equipment so that it does not become a place for pests to hide.
- Remove all litter, weeds, and grass clippings.
- Eliminate any waste that may accumulate near exhaust systems.
- Use rodent, insect, and bird traps as necessary.

Chemical Control

- Baits for rodents.
- Baits, fogs, and sprays for insects.
- Chemical repellents or avicides for birds.

PESTICIDES

AEROSOLS

ADVANTAGES:
- Excellent for flying or exposed insect pests.
- Disperse well if used correctly.
- Convenient and easy to store.
- Usually leave little surface deposit.
- Store well during normal use period.
- Available for hand operations or can be installed as a timed release system.

LIMITATIONS:
- No lasting protection.
- Good only for exposed pests.
- Hazardous if container is punctured or overheated.
- Usually cannot be used during food processing or when people are present.

LIQUIDS

ADVANTAGES:
- Usually provide a deposit on surface.
- Can be easily directed onto surface for treatment.
- Easy to store, transport, and handle.
- Adaptable for use in many kinds of equipment.

LIMITATIONS:
- May be hazardous to use around electrical outlets (water or oil sprays).

- May damage or stain wallpaper, varnish, and many fabrics (water or oil sprays).
- May leave unsightly residue (wettable powders).
- Require agitation during application (wettable powders and emulsions).
- May be hazardous around open flames (oil sprays).
- May damage or etch asphalt, plastic tile, or rubber products (oil sprays).
- May make floors slippery (oil sprays).
- May damage living plants (oil sprays).

DUSTS

ADVANTAGES:
- Excellent for crack and crevice treatments.
- May be purchased ready-to-use.
- Usually require only simple and lightweight application equipment.
- Safe for use around electrical equipment.

LIMITATIONS:
- Drift easily.
- Easily dislodged from treated surface (should not be applied on equipment or above food-contact surfaces).
- Generally bulky to store.

GRANULES

ADVANTAGES:
- Ready-to-use.
- Do not drift.

LIMITATIONS:
- Can be used only on fairly level surfaces.
- May be tempting to nontarget animals.

BAITS

ADVANTAGES:
- Can often control specific pests.
- Easily distributed.
- Easily monitored and recovered.
- Used in small amounts.

LIMITATIONS:
- Can be dangerous to nontarget animals.
- Often not as attractive as natural food supply.
- Rodents must feed for 5 to 15 days on an anticoagulant rodenticide before it is lethal.
- Rodents feeding on poison baits may die anywhere and go undetected, causing sanitation problems.

FUMIGANTS

Fumigants penetrate cracks, crevices, and the commodity being treated. They must reach the target pests as gases to be effective. As soon as a fumigant diffuses from the target area, reinfestation can occur. Fumigants must be applied in enclosed areas.

Types of Fumigation

Types of fumigation are:
- general fumigation (buildings and their contents),
- spot fumigation (machinery, facilities, bulk commodities),
- tarpaulin or chamber fumigation (packaged commodities), and
- vehicle or in-transit fumigation (trucks, ships, and railway boxcars).

Selection of Fumigants

When choosing a fumigant, consider:
- toxicity to the target pest,
- volatility and ability to penetrate,
- corrosive, flammability, and explosive potential,
- warning properties and detection methods,
- effect on seed germination and finished product quality,
- residue tolerances,
- availability,
- ease of application, and
- cost.

Several factors can change the efficiency of fumigants. Consider these when selecting a formulation and dosage:

Temperature—The fumigant may not kill the pests if the product or space being fumigated is below 10° C (50° F) or above 46° C (115° F).

Moisture—As the moisture content of a commodity increases, it becomes more difficult for a fumigant to penetrate it. This also increases the potential for residues exceeding legal tolerances. Adequate moisture is required for the generation of some fumigants.

Pests—Susceptibility to fumigants depends on species, habitat, and stage of development. During some stages of their life cycle, for example, many insects are protected by the product they infest.

Structure—Consider the condition of the structure, the type of construction, and the product it contains.

Remove and dispose of packaging and waste products of solid fumigants.

Fumigants are useful but have specific advantages and limitations.

ADVANTAGES:

- Toxic to many pests.
- Can be applied by various methods.
- Easy to apply without disturbing the commodity.
- Penetrate structures, commodities, and equipment.
- Readily available and economical.

DISADVANTAGES:

- Toxic to humans.
- Require trained applicators.
- Target area or commodity must be enclosed.
- May injure seed germination.
- Temperature requirements may be hard to meet, especially in northern climates.

VAPORS

Vapors are volatilized by supplementary heat or by inherent high vapor pressure to produce a gas. They are usually dispersed from impregnated resin strips, or vaporizers.

ADVANTAGES:

- Easy to apply and safe to handle.
- Can be used where fumigant tolerances may be exceeded.
- Sealed building not as essential as for fumigants.
- Effective against flying insects such as moths and flies.

DISADVANTAGES:

- Will not penetrate commodities in concentrations lethal to target pests.
- Resin strips cannot be used in plant areas where food is exposed.

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